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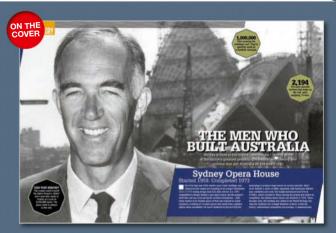
THIS IS LANDCRUISER COUNTRY.





Knowledge

CONT



Ambitious projects like the Sydney Opera House and the Great Ocean Road put Australia on the map.

But who were the heroes behind them?

PAGE 10



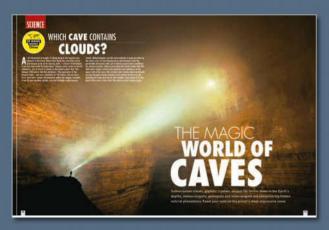
Experts have described the Fairchild A-10 Thunderbolt as old and slow. Yet there's still no shortage of pilots keen to clamber into its cockpit.

PAGE 42



Astronomers have found a monster star that challenges our understanding of how big suns can grow. This giant is 300 million times heavier than Earth.

PAGE 66

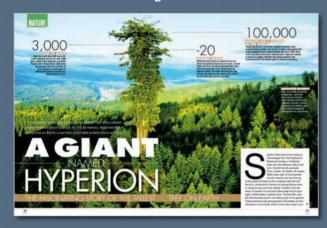


Subterranean weather systems, gigantic crystals,
- explorers continue to uncover incredible phenomena
in Earth's hidden underground caves. PAGE 22



Welcome to Canada's Gulf of Saint Lawrence, where powerful ocean currents produce an incredible marine environment that's teeming with life.

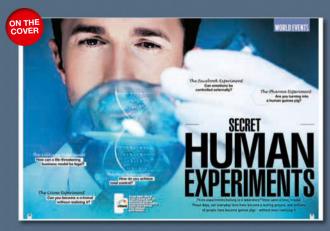
PAGE 48



In a remote part of California, massive redwood trees grow to over 100 metres tall. But there's one that stands head and shoulders over the rest. PAGE 70

JANUARY 2015

ENTS



In the search for a suitable testing arena for their experiments, scientists are eschewing laboratories in favour of our everyday lives.

PAGE 30



Dreams reveal unknown information about our lives.

Once the domain of psychologists, they're now helping neurologists make spectacular breakthroughs. PAGE 58



From the birth of the Nazi party to the rise of Islamic State, we chronicle the extraordinary events that have changed the face of the world forever.

PAGE 76



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NATURE

48 The Cradle Of Life

Natural wonders in the Gulf of Saint Lawrence

70 A Giant Named Hyperion

The biggest tree on Earth and its fascinating secrets

WORLD EVENTS

30 Secret Human Experiments

How our everyday lives have become a giant laboratory

84 Dr Z And His Legal Highs

Meet the shadowy figure staying one step ahead of the law

SCIENCE

22 The Magic World Of Caves

The amazing phenomena hidden deep underground

66 When Science Found The Monster Sun...

Star R136a1 is rewriting the laws of physics

TECHNOLOGY

42 The Immortal Fighter

The combat jet proving old doesn't mean past it

HUMAN BODY

58 What Your Dreams Really Mean

15 questions about dreams – answered by neuroscientists

HISTORY

10 The Men Who Built Australia

The heroes behind the nation's greatest projects

76 The Untold History Files

Part 1 in a series of earth-shattering events

REGULARS

8 Amazing Photo

Fascinating photos - and the stories behind them

90 Questions & Answers

Amazing facts from science, technology and everyday life

96 And Finally...

Croc Diving: not your average morning swim

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WHEREVER **YOU SEE** THE VIEWA LOGO

DANGEROUS EXPERIMENTS
Find out which tests could have wiped out mankind p30

FIGHTER-JET AIR SHOW
Watch planes perform spectacular
fly-bys. Your ears may hurt p42

THE SCIENCE OF DREAMS
Could we *record* them one day? p59

UNIVERSE'S BIGGEST SUNS

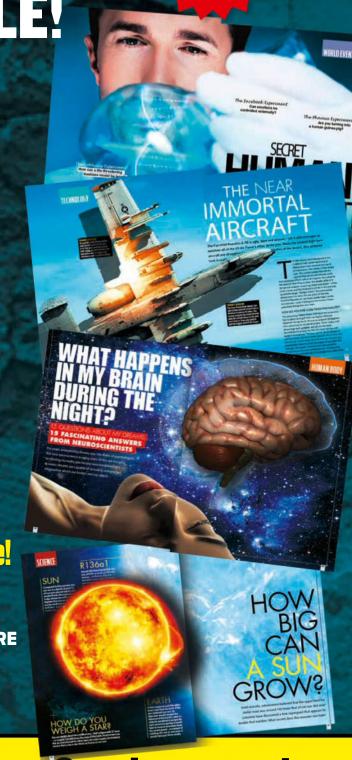
The stars that make our own sun look miniscule **166**

More great extras throughout the issue!



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It's fitting that in an issue featuring a lead story on human experiments, we should also be celebrating the men who built Australia. Because in many ways, the country we call home was itself an experiment. Step one: take an unmapped land mass with no history of industrialisation or urbanisation. Step two: fill it with people from all corners of globe who have little in common culturally. Step three: stand back and watch the action unravel over the next 200 years. Step four: keep fingers crossed.

The results have been pretty outstanding. Money can't buy happiness, but over two centuries Australia has become a major economic world power, with living standards

> soaring above the world average: 72% of people aged 15 to 64 have a paid job, life expectancy is 82 years (two above the average) and our sense of community is strong (93% of people believe they know someone they can turn to in times of need). And more than 83% of us are generally satisfied with our lives. What was that about money?

There have been ups and downs. Mistakes made, lessons learned. But we've all had a walk-on part in the soap opera that is the Great Australian Experiment. The nation's success is your success. So enjoy your end-ofyear break, and give yourself a patriotic pat on the back. Vince Jackson, Editor



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o<mark>rld of Knowledge on the App Store. It's only \$4.99 per issue,</mark> It's just like the mag (except it's harder to swat mozzies with)

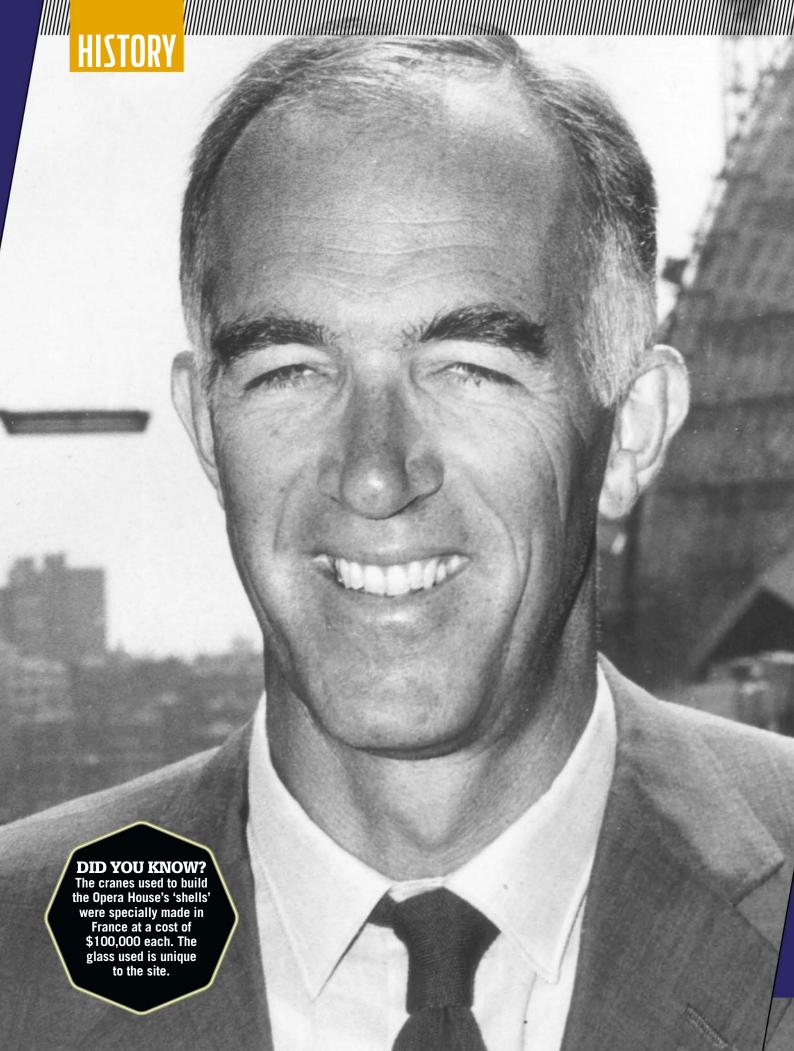
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1,000,000 tiles cover the building's roof. They're specially made by a Swedish company.

> kilometres of cable hold the roof together. Laid end-to-end, they would easily reach Canberra.

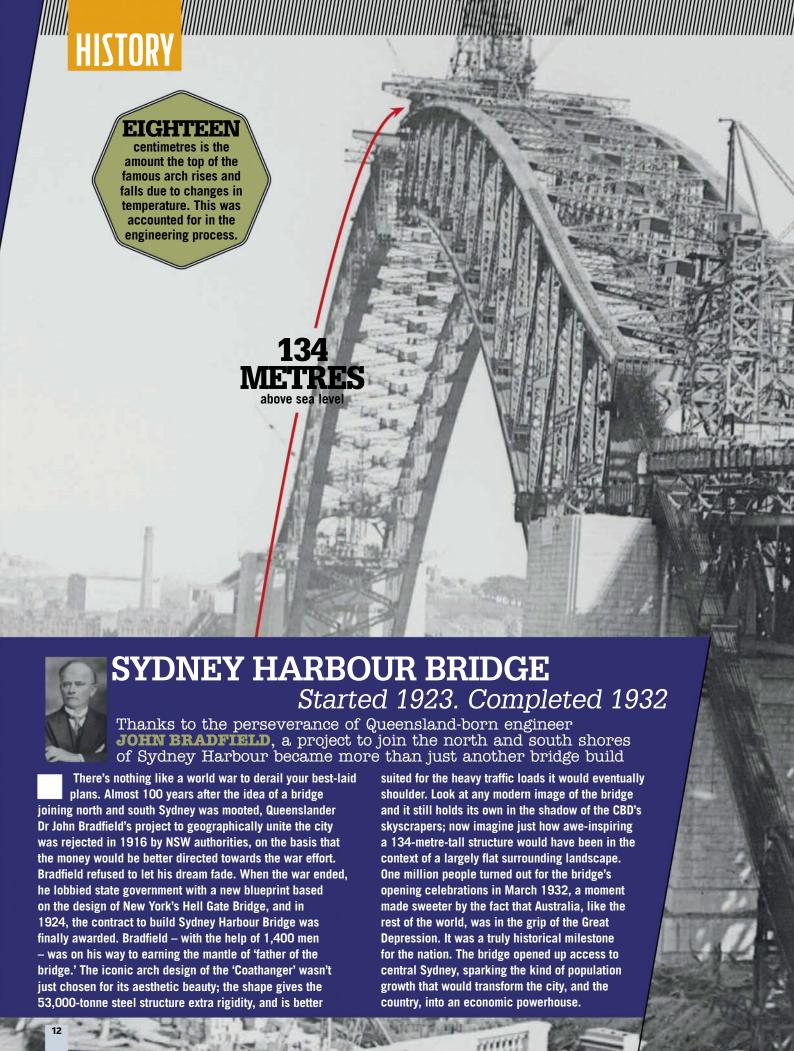
THE MEN WHO BUILT AUSTRALI

We pay tribute to the brains – and brawn – behind some of the nation's greatest projects; the feats of engineering and science that put Australia on the world map

Sydney Opera House Started 1959. Completed 1973

Can it be that one of the world's most iconic buildings was inspired by the simple act of peeling an orange? Dane JØRN UTZON's daring design beat 232 other entries in a 1957 competition to design Sydney's new opera house, but the project's shell-like roof was soon giving the architect headaches - until Utzon looked at his humble piece of fruit and realised he could construct a building of 14 outer pieces that would form a perfect sphere when assembled. He wasn't bothered by the fact that the

technology to produce large pieces of curved concrete didn't exist. Despite a series of bitter arguments with Australian officials over schedules and costs (the budget ballooned from \$7m to \$130m), which resulted in Utzon leaving the project just before its completion, the Sydney Opera House was unveiled in 1973. Since then, the landmark has brought Australia priceless amounts of international recognition and prestige, plus of course millions of tourism dollars. The building remains on the World Heritage list.





HISTORY

1858

Sydney and Melbourne are linked by electric telegraph

1860

John McDouall Stuart reaches the centre of Australia. Pushes on to Darwin by 1862

1861

Burke and Wills embark on their ill-fated mission across central Australia

1872

The Overland Telegraph Line linking Darwin and Adelaide opens

1878

First horse-drawn trams operates in Adelaide

1882

First water-born sewerage service begins operations in Adelaide

1883

The Sydney-Melbourne railway is opened, linking the country's two biggest cities

1900

First Australian constitution passed by the UK parliament

1902

King Edward VII approves design of <u>the Aus</u>tralian flag

1908

Canberra chosen as the national capital

1910

First powered aircraft flight in Australia by visiting magician Harry Houdini in Victoria





The Boomerang's design engineer was a political refugee: Austrian-born Fred David worked for the Heinkel aircraft company in Germany, but fled the country when the Nazis began persecuting Jews.

SIX

armaments were carried by the Boomerang; two 20mm cannons and four .303 calibre machine guns mounted in the wings – superior weapons to those of its rival Japanese plane the 'Zero'.

DR



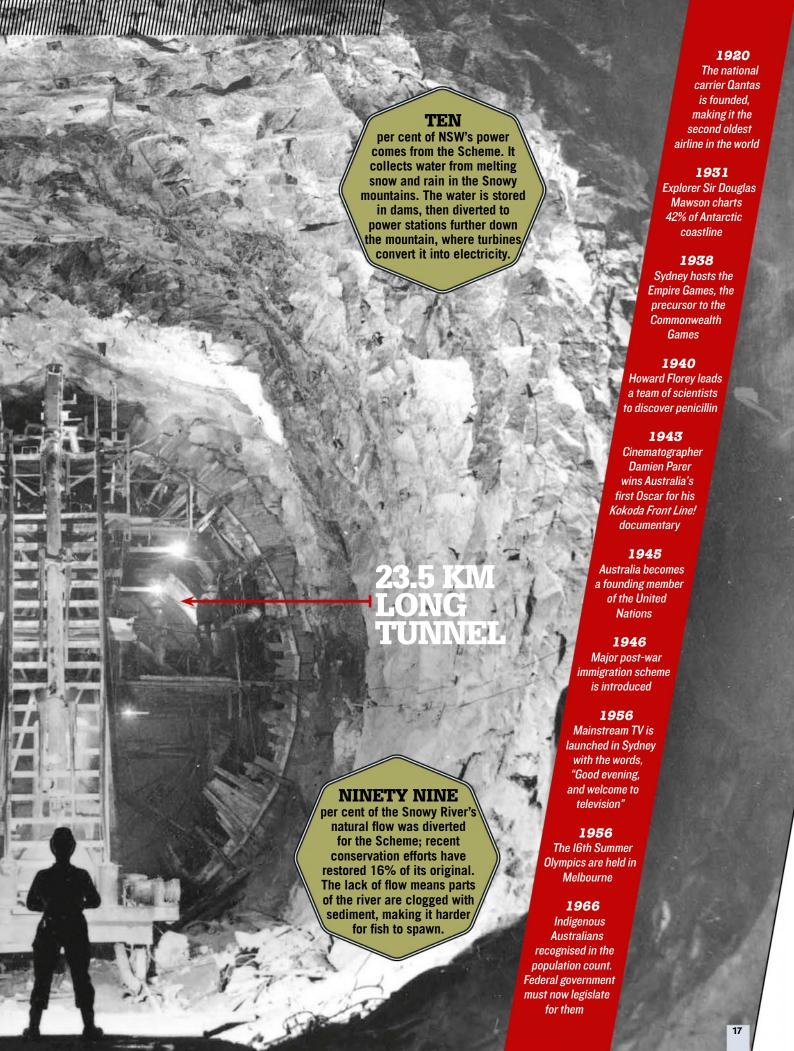
Started 1941. Completed 1943



It was 1942, in the middle of some of the darkest days of World War Two. The threat of Japanese invasion was real. The Imperial air force had already bombed Darwin Harbour, killing more than 200 people. The British had surrendered to the Japanese in Singapore. In this context, Australia's air defences were woefully under-equipped. Luckily, Lawrence Wackett had impressive aviation form; he was one of 21 pilots who formed the nucleus of the original RAAF, and had built a reputation for his design work on both military and civil aircraft. But it was as general manager of the Commonwealth Aircraft Corporation that Wackett played a central role in protecting Australia, overseeing development of the Boomerang, the first combat plane designed and built in Australia. While the small, 7.7-metre-long plane lacked the firepower and speed of the British-built Spitfires, its secret weapon was its agility and low-altitude performance,

enabling pilots to fly reconnaissance missions over Japanese positions, or get close to ground targets in the jungles of Borneo and the Solomon Islands. "Any fighter which could destroy a Japanese bomber or ship-borne reconnaissance aircraft was of value, if only for second-line defence," recalled Wackett in his memoirs. The Boomerang was also used in important support roles, both in assisting larger aircraft, and air-sea rescues in New Guinea. All up, 250 Boomerangs were built between 1942 and 1945, under five different specifications; later models were 30% faster and could fly 1,200 metres higher. Sadly, Wackett experienced personal tragedy in 1944 when his only son, Wilbur, died while serving as a combat pilot. Ten years later, Wackett was knighted "in recognition of his outstanding pioneering services to the Australian aircraft industry". The RAAF continued to choose its combat planes based on Wackett's recommendations.





HISTORY

1968

liver transplant is performed at St. Vincent's Hospital, Sydney

is the first Indigenous Aussie to become a member of parliament

1972

ensuring that women who do the same job as men must be paid the same wage

1973

Patrick White is the first Australian to win the Nobel Prize

introduces the Aboriginal Land Rights Bill into

1982

National Gallery of Australia is opened in Parkes, ACT, going on to hold more than 166,000 works of art

1983

The Australian dollar is floated, allowing it to fluctuate independently on international money markets

Fair is introduced as the official

1988

The country marks its bicentenary with massive celebrations

The nation's first

1971

Neville Bonner

Legislation passed

in Literature

1975

PM Gough Whitlam **Parliament**

1983

Advance Australia national anthem

nationwide



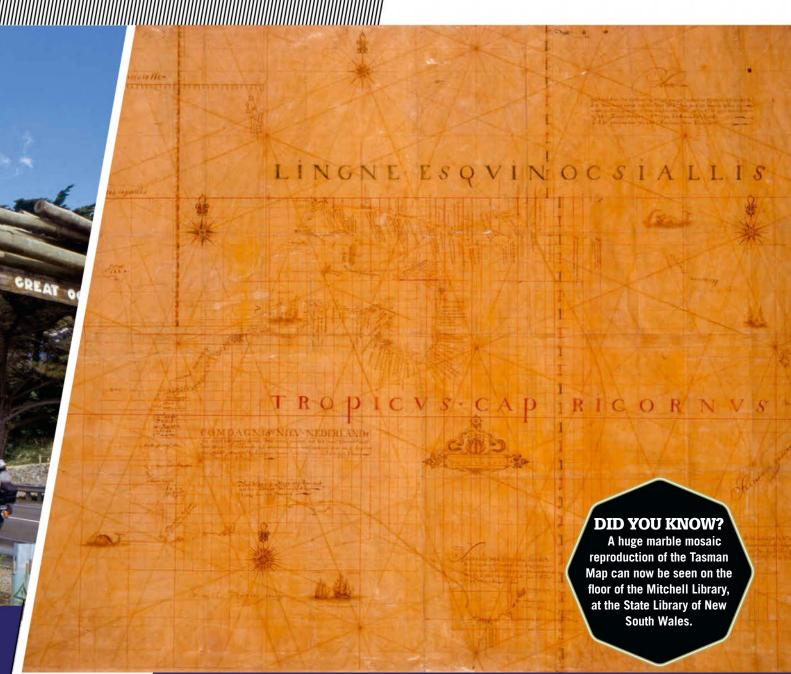
GREAT OCEAN ROAD

Started 1919. Completed 1932

Geelong mayor and philanthropist HOWARD HITCHCOCK dipped into his own pocket to make sure one of Australia's most breathtaking feats of engineering became a reality

When the question 'What is the world's biggest memorial?' pops up in a trivia quiz, you can now be confident in your answer. The Great Ocean Road, a 243-kilometre-long tarmac serpent hugging the Victorian coastline, is a permanent dedication to those who died during World War One. It took the enthusiasm of Geelong mayor Howard Hitchcock for the proposal to get off the ground. He imagined the project working in three ways: as a means of providing returning diggers with work, to establish an everlasting monument to those who died during the Great War, and, not least, as a tourist attraction with views to rival those of the French Riviera. Hitchcock set up the Great Ocean Road Trust, and busied himself with raising the funds needed to start construction, securing £81,000 (\$150,000) from private investors and

chucking in £3.000 (\$1.300) of his own money. The remaining debt amassed during building would be paid back by road tolls. When an advance survey team began work in September 1919, progress was slow - about three kilometres a month. There was no heavy machinery to help bore through steep coastal mountains; labour was done by hand with picks, shovels and, perilously, explosives. Deaths became inevitable. In March 1922, the first section of the Great Ocean Road was opened from Eastern View to Lorne. Sadly, Hitchcock died of heart disease in August 1932, iust months before the entire road was finished. There remains a memorial to the man himself on a stretch of bitumen near Lorne; a memorial within a memorial, if you like.





THE TASMAN MAP

Started 1644. Completed 1695

It's debatable whether Captain James Cook would have ever found the mysterious continent known as New Holland without the map-making genius of **ABEL TASMAN**

Compared to today's precise digital maps, the Tasman Map (above) looks decidedly clunky. But once you consider that its creator, Dutch explorer Abel Tasman, had never set foot on Australian soil when he made it, and performed his observations from sea, 320 years ago, the chart suddenly looks astonishingly accurate. The Tasman Map, hand-drawn on delicate Japanese paper, is an amalgamation of two of the seaman's previous charts; the one he made during his famous southern trip – where, among other things, he came across the island eventually named after him, Tasmania – and his lesser-known attempt at exploring

the north of the country. As with all maps of Australia from that era, parts of the continent were missing from Abel Tasman's map (squint and you'll see that in this case some of the Eastern seaboard is blank). But such was the Dutchman's acumen, James Cook used the chart to successfully navigate his way to Port Jackson in January 1788 – almost 100 years after the Tasman Map was drawn. It's safe to say that without the map, the course of Australian history could have taken a different turn. Abel Tasman's legacy lives on in the various places, roads and landmarks named in his honour. W

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SCIENCE



WHICH CAVE CONTAINS

CLOUDS?

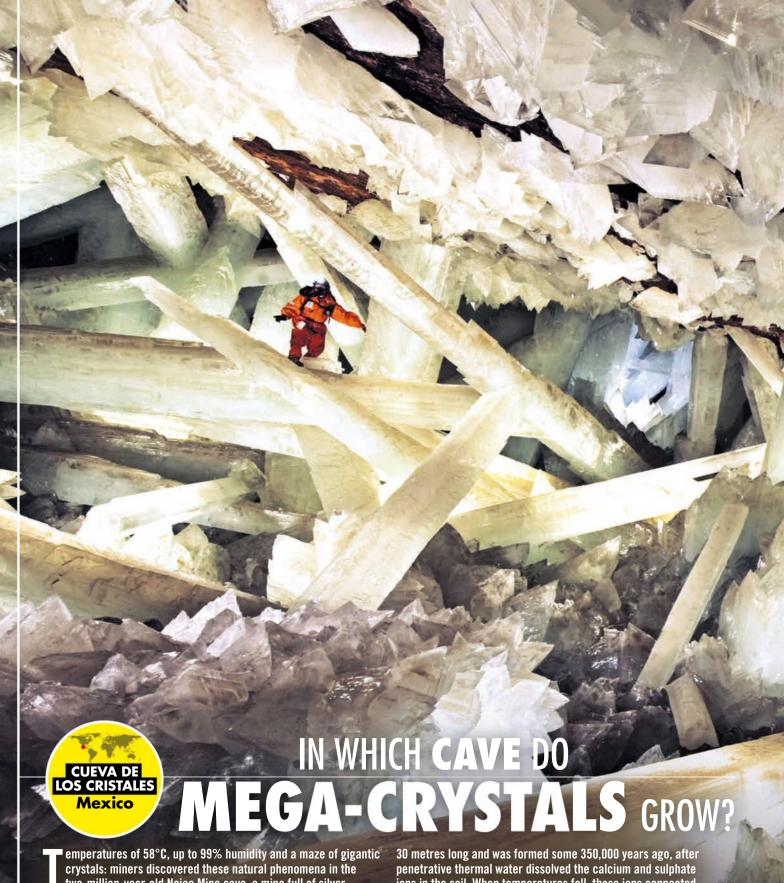
t 42 kilometres in length, Er Wang Dong is the largest cave network in the world. Rivers flow along the cave floor, ferns and mosses grow on its soaring walls — a forest of deciduous trees has even made its home there. Tunnels mark routes to secret chambers, one of which is known as the Cloud Ladder Hall. This plunges 250 metres into the darkness — the equivalent of five Niagara Falls — and has a diameter of 150 metres. Researchers have observed a unique phenomenon within this mighty chamber: it has its own weather system, one that includes subterranean

clouds. Meteorologists say this microclimate is made possible by the cave's size, its low temperatures and moisture from the permeable limestone walls, all of which present ideal conditions for cloud formation. These occur when the Cloud Ladder Hall fills with water vapour, which rises upwards and condenses in the upper half of the cave. This creates thick clouds which eventually escape through a small opening in the ceiling and turn to rain, meaning the cave also has its own weather zone above it. As the level of the cave's river rises, the whole process begins again.



THE MAGIC MORLD OF CLICK STATE OF THE STATE

Subterranean clouds, gigantic crystals, unique life forms: down in the Earth's depths, meteorologists, geologists and mineralogists are encountering hidden natural phenomena. Feast your eyes on the planet's most impressive caves



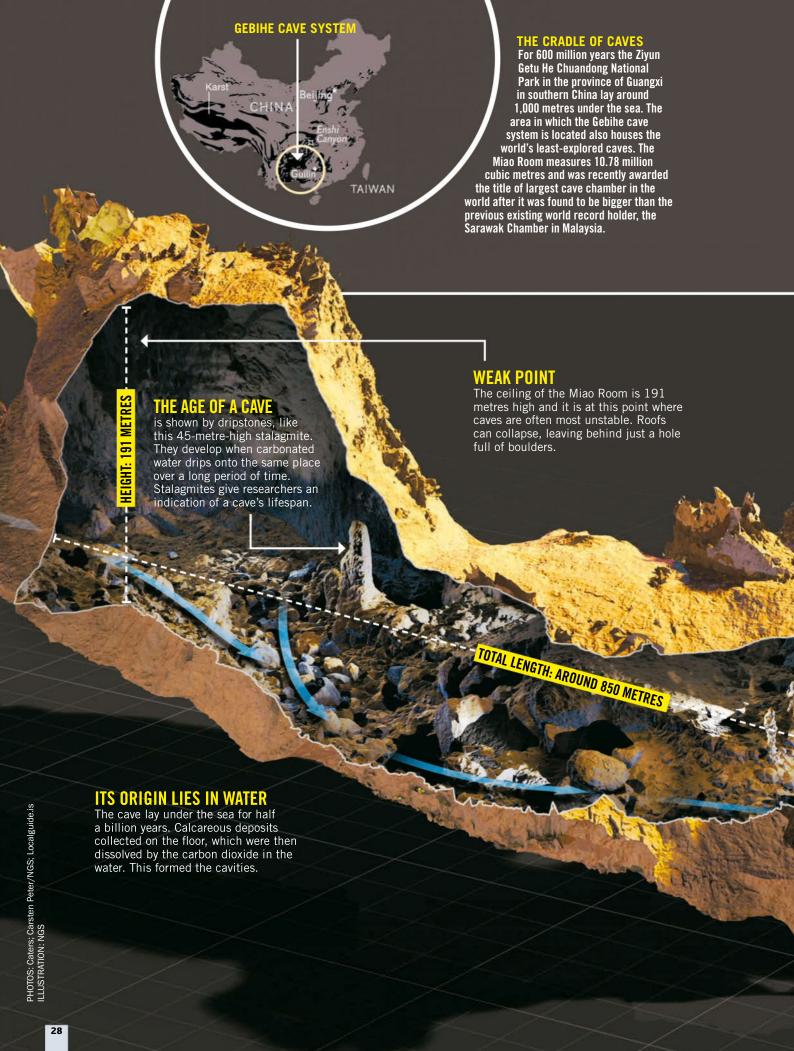
emperatures of 58°C, up to 99% humidity and a maze of gigantic crystals: miners discovered these natural phenomena in the two-million-year-old Naica Mine cave, a mine full of silver, lead and zinc directly under the Chihuahuan Desert in Mexico. The grotto with the largest crystals in the world is nestled in the mine's limestone rock 300 metres underground. Made of selenite, a very pure and shiny gypsum, the biggest crystal is four metres in diameter, 12 metres long and weighs 55 tons — as much as 11 African bush elephants. The crystalline landscape is around

30 metres long and was formed some 350,000 years ago, after penetrative thermal water dissolved the calcium and sulphate ions in the soil. When temperatures fell, these ions connected themselves to selenite crystals. Over the centuries, in the cave's unchanging climate, the crystals have kept on growing. The crystal cave is a life-threatening environment: the hot and humid air underground leads to breathing difficulties, fainting and heatstroke. Because of this, experts can only enter the cave when wearing protective suits and oxygen masks.







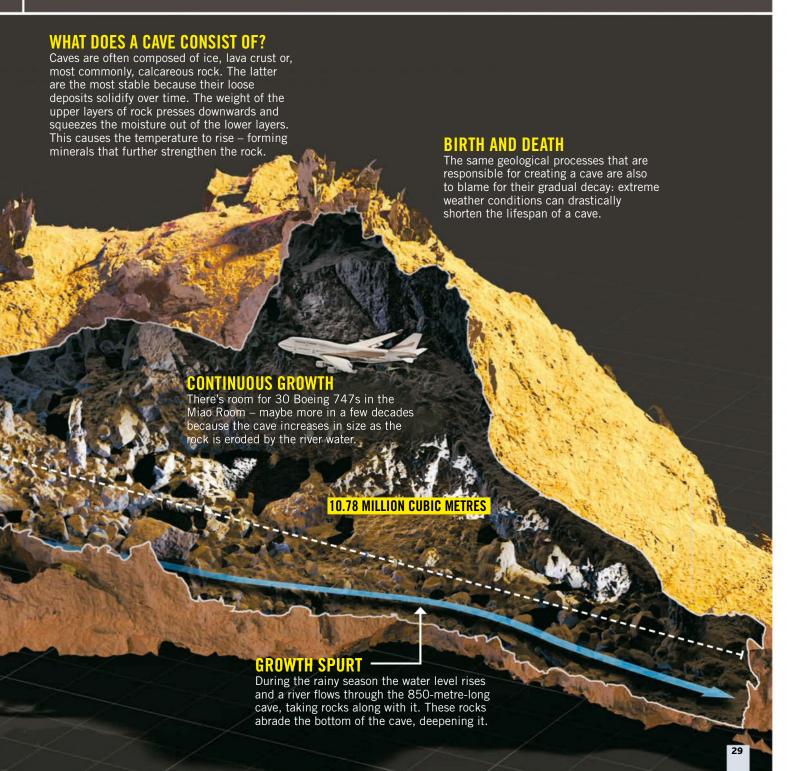


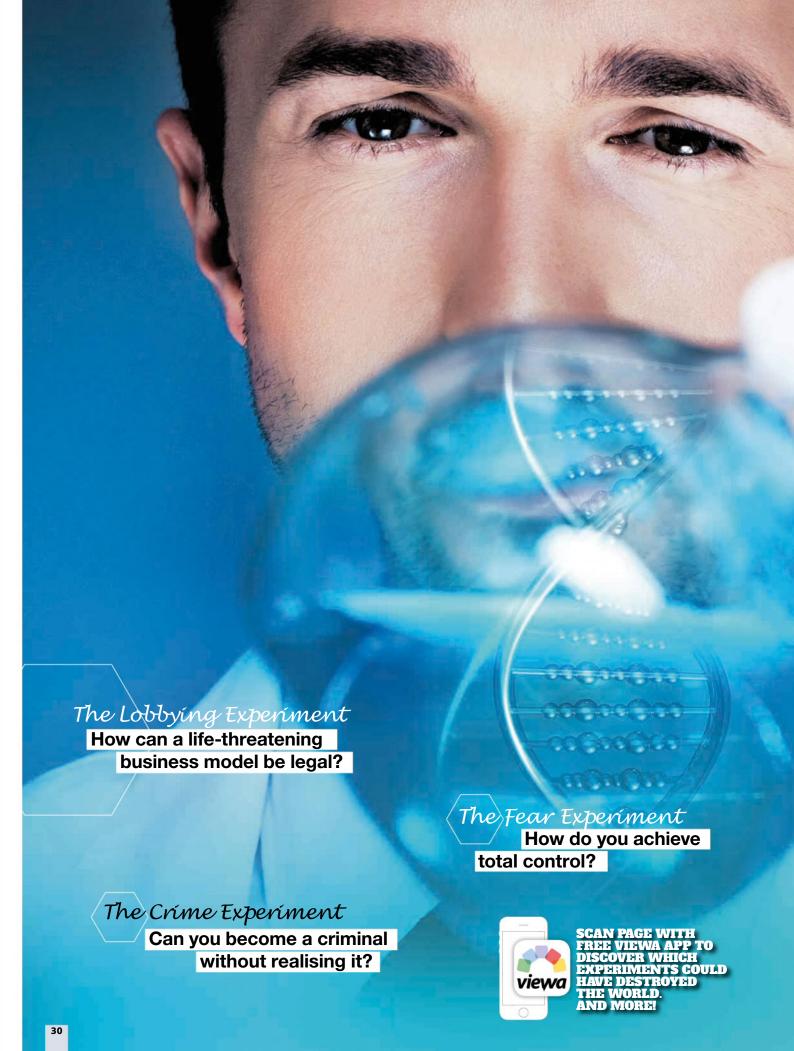


HOW OLD CAN A CAVE BECOME?

aves are like living organisms: they are born in water, grow very slowly and subsequently die — what creates them can eventually destroy them. They develop through geological processes like corrosion (chemical weathering), erosion (mechanical weathering), tectonics (movement of the Earth's crust or layers of rock) or a combination of all three. These processes are ongoing, so a cave can never be considered 'fully grown': subterranean rivers carry stones with them, which erode calcareous rock

and deepen the chamber. The lifespan of a cave depends mainly on two factors: the material it's made from and the surrounding environmental conditions. Earthquakes, heavy rain or gale-force winds can trigger collapses as they fill the cavity with debris and boulders smash in the walls — the cave becomes a part of the Earth's surface. While ice caves normally last only a few years, caves made of calcareous rock can last up to a million years.





WORLD EVENTS

The Facebook Experiment

Can emotions be controlled externally?

The Pharma Experiment
Are you turning into
a human guinea pig?

HUNAN HURAN EXPERIMENTS

Think experiments belong in a laboratory? Once upon a time, maybe.

These days, our everyday lives have become a testing ground, and millions of people have become guinea pigs – without even realising it

icture a world
where shady
scientists join
forces with a
government
with the aim of
controlling the
population. It

sounds like a nightmare dystopian future - but it's happening right now. 'Wirksam Regieren', or 'Effective Governing' is the name used by a group of top officials and scientists who have been meeting with the German government for months. What they're discussing is not new laws. They want to control the German population much more effectively than any official directive could. That's why the government has green-lit a completely new type of experimentation - the laboratory is Germany, and 82 million people are its unsuspecting guinea pigs.

DOES THE GERMAN GOVERNMENT HAVE A BRAINWASHING UNIT?

"People are not very good at making sensible decisions,"

ARE THERE LIVING LABS?

In a project run by the Massachusetts Institute of Technology (MIT), an entire region of Italy became a living laboratory. For two years, participants of 'Trentino as a Lab' have been sending automated details about their lives and their surroundings to the lab. And that's not all: "Every citizen becomes a living sensor: more data, more precision, lower costs," according to the project's mission statement.

explains psychologist Daniel Kahneman. Rules and laws tend to encourage dissent – and are actually far too expensive. The Effective Governing project group, known by some as the brainwashing unit of the German government, wants to bypass that. Like in a laboratory, there are various types of experiments which researchers can use to update old concepts and try out new ideas: what works, what doesn't?

This concept is called 'nudging' and was invented by the American professors Richard Thaler and Cass Sunstein, both of whom also work for the UK and US governments.

In practice their tricks can be extremely subtle: for example, the Inland Revenue in the UK often runs tax evasion publicity campaigns which focus heavily on guilt and the fear of 'what the neighbours would say'.

They also play with the subconscious: adding a sentence on tax returns stating "I promise that the following information is correct to the best of my knowledge" is believed to bring the Exchequer more than \$400 million in additional income every year.

This might sound harmless. But in reality, government 'nudgers' are overstepping the mark: "People's behaviour is being controlled without them noticing," says Jan Schnellenbach, an expert on behavioural choice theory. If people knew what was going on under their noses, it would be a lot harder for the government to operate.

But the success gives the nudgers authority – and opens the doors for even more 'nudging' of the citizens. But where to begin? Every one of us contributes – constantly, every hour of the day. Our lives were turned into a huge laboratory experiment long ago: "For much of history, scientists had a small test group to work with.

Today, however, researchers can draw massive amounts of data easily from our everyday lives," explains Gillian Tett, an anthropology expert. In the process, people become variables; the laboratory observes their reactions. "Social physics" is how Alex Pentland from the Massachusetts Institute of Technology describes this new strand of science.

"To see how things function in reality, we must set up living laboratories," he says. He is talking about volunteers – but the reality has often gone further than that. Our lives are observed, analysed and manipulated without us even noticing. Behind our backs, our very existences have become living laboratories. In this special report, *World of Knowledge* uncovers the most extreme cases...

If we can't rely on labs any more, we must do tests in the real world.

Alex Pentland, MIT researcher



ver the course of its 130-year history, the science journal Nature had never withdrawn an article. But when the microbiologist Ignacio Chapela proved that, despite the protestations of the manufacturers and GM scientists, genetically modified plants had become widespread in the wild through cross-pollination, bio-tech company Monsanto kicked up a massive fuss to prevent the article being published.

The biotech industry, which earns billions from its licence fees on GM plants, attempted to smear Chapela and his experiments. They claimed he was nothing more than an anti-GM activist. Meanwhile, it's estimated that 70-80% of food produced in the USA comes into contact with GM technology, making it a multi-billion dollar industry. "And an experiment, in which we are all human guinea pigs," argues Andrew Kimbrell, head of the Center for Food Safety in Washington.

Almost all the research into GM food is financed by the biotechnology sector – only 5% of scientists are independent. One of the few is Arpad

LLThe agrochemical lobby is one of Brussels' strongest. They're aggressive.

Nína Katzemích, Lobby Control

Pusztai. "I would never eat genetically modified food," the biochemist said, after his experiments on rats showed their bodies underwent 36 changes when they were fed GM food. These included an increase in the size of their intestines and kidneys. After publishing his findings in 1998, Pusztai lost his job at the Rowett Research Institute in Aberdeen.

The industry also tries to exert its influence in Europe: "The agrochemical lobby is one of the strongest in Brussels. Their behaviour is sometimes very aggressive," says Nina Katzemich from Lobby Control, an organisation which campaigns for greater transparency in politics.

While there are no GM fresh foods approved by Food Standards Australia and New Zealand, some other packaged products are genetically modified – but they must have their GM status displayed on their labelling. However, there are exceptions to this standard: GM ingredients in highly refined products (cooking oils, sugars, baked goods) don't need to be listed, and current legislation allows companies to include up to 1% of GM organisms in food without labelling it as GM.

"If you move a gene, one tiny gene, out of an organism into a different one you completely change its context. There is no way to predict how it's going to behave and what the outcome will be," explains the environmentalist David Suzuki. His view is one now shared by many. They argue that more science is needed to understand the unintended consequences of GM food.



The Crime Experiment Can you become a criminal without realising it?

t is still early in the morning when Robert McDaniel is visited by officials from the Chicago Police Department. Although the 22-year-old high-school dropout has not committed a crime or been identified as a witness, the police officers' warning is clear: "We are watching you. Don't step out of line!" What McDaniel is unaware of is that he's one of a million participants in a mass experiment which has already been running for four years: predictive policing. This process uses highly complex algorithms and thousands of parameters to produce a crime prediction service in real time.

As a result of his past (shoplifting as a teenager), his neighbourhood (a problem area) and his contacts (a friend was recently shot), McDaniel has been placed on the Chicago Police Department's Heat List. Right now 420 suspects are being monitored. They have been categorised as 'criminal time bombs' by the computer, and may be more likely to commit a crime in the near future. Though the program has

Surveillance is a weapon for humans who want to control other humans.

Jens Hälterlein, pre-crime expert

.

reduced crime rates in many
US cities, prevented crimes and
identified potential murderers,
critics say that predictive policing
puts innocent citizens like McDaniel
on the police's radar and is little
more than racial profiling. In the
future it could be used to manipulate
the behaviour of millions of people.

It's not just scientists and the US government that are interested; it's believed at least one Australian police force have enquired about the technology, and the EU experiment INDECT has been operating since 2009. Liberty's Shami Chakrabarti said on the project's launch: "Profiling whole populations instead of monitoring individual suspects is a sinister step in any society. It's dangerous enough at national level, but on a

Europe-wide scale the idea becomes positively chilling. "INDECT's experiments use algorithms to categorise images from CCTV cameras to identify and predict suspicious behaviour.

"If you're sitting in a train station and three trains have passed without you getting on, then it would rate that as abnormal behaviour," says pre-crime expert Jens Hälterlein. He's convinced that the more the public knows about these surveillance techniques, the more it will influence the behaviour of its involuntary participants.

Lab tests show that people behave differently when they know they are being watched. Hälterlein concludes: "Automatic video surveillance is a weapon: an aid for humans who want to control other humans."



It is easier, it is cheaper. Above all, you can trample on patients' rights. 77

Artjom Golowin, chairman of the All-Russian Multiple Sclerosis Society

The Pharma Experiment How quickly can you become a human guinea pig? of New York. But companies a



illie Trottie spends his final hours on death row, in advance of his execution in Texas.

"I am actually quite calm," he says.

"Only the drugs make me worry.

They're experimenting with us." The prison authorities refuse to say where they got their drugs, or if they have been properly tested. Trottie is right to be concerned; earlier this year some death row prisoners took hours to die from their injections.

The two-million-plus prisoners in the USA also serve as human guinea pigs for the pharmaceutical industry. "Many prisoners receive medicines in blank packages. They don't know what they're taking," says Prison Policy Examiner Susan Hillman. Until 1972 the health sector actually conducted 90% of their studies on prisoners.

A few years ago a pharmaceutical firm carried out secret experiments on HIV-positive children from foster families with the consent of the state of New York. But companies are now increasingly looking to developing countries as places to carry out their experiments. "It is easier, it is cheaper. Above all, you can trample on patients' rights," says Artjom Golowin, the chairman of the All-Russian Multiple Sclerosis Society. Alongside India, China and Indonesia, Russia is at the centre of a new industry, which outsources its experiments. "The doctors say to the patients: If you don't take part in this study, you won't receive treatment because we won't have any money to pay for it," explains Alexander Globenko, who coordinated one of the medical trials involving a new drug.

It is estimated that Western pharmaceutical companies can reduce their research costs by around 60% by outsourcing their work. Together with the genetic diversity of its huge population, lax regulations in India make the country an ideal location. But campaigners claim the individuals taking part in the trials are often the poorest in society who can't read or write and don't know what they have signed up to.



Can your emotions be controlled externally?

■ very sixth person on Earth 'lives' on Facebook. In total, more than a billion people effectively have dual citizenship on Facebook, which takes up roughly 17 minutes of their day, every day. But those in control of the biggest nation in the world like to avoid the limelight as much as the government of North Korea - not much is known about the hierarchy of the organisation other than the identity of its founder and CEO, Mark Zuckerberg. And for good reason: Facebook can be likened to a social experiment carried out by a modern nation - except the online regime works in a far more arbitrary and manipulative fashion. If the true extent of its experiments were to become known, a mass exodus could occur from the country of Facebook...

The citizens are the goods which Facebook provides to its advertisers. It allows them to be manipulated, as any new resident consents to the user agreement when they register. In fact, in order to find out how emotions can be controlled effectively, Facebook deliberately altered the newsfeeds of 700,000 unsuspecting users during one week in January 2012. One test group received negative stories, the other mostly positive information. The result? Good moods increased - and bad ones did, too. The people reading the positive news releases began to express themselves more positively

 and vice-versa. There was a storm of protest when the details of the experiment were revealed recently but this was no one-off case.

"We carry out thousands of tests every day," an anonymous Facebook data scientist reveals. "While many of these tests are used for the optimisation of specific results, others are intended to provide the foundations for long-term design decisions."

But what's the point? If you are able to control emotions in a targeted fashion, you are also given the means with which to steer people in a particular direction. "Mostly, people make decisions without calculating the usage and probability," explains psychologist Gerd Gigerenzer. The experiments have garnered interest from political parties, businesses and lobbying firms - and no wonder: hack into these subconscious processes and you have a weapon with which to influence the decisions of millions of people across the globe, be that in the next election or when launching a new product.

The Fear Experiment How do you achieve total control?

US NR FORCE

ow do you hack into the psyche of thousands of people, without ever setting foot in their city?

How do you manipulate their behaviour without ever coming into contact with any of them?

And how can you change the entire public life of a region, including even the health of its residents?

What sounds like mission impossible has actually now been achieved by the US government.

The arena for this highly controversial experiment is the Pakistani border city of Miranshah. Just a few years ago it was a peaceful place, but today the locals are terrified. The streets are deserted and many people suffer from panic attacks. "Sales of anti-depressants and sedatives have exploded in recent years," explains local pharmacist Hajji Gulab Jan Dawar. It's as if an invisible virus has swept through the city and eaten deep into the minds of the people. The explanation is controversial: to this day, no other place in the world has suffered as

many drone strikes as Miranshah. At least 80 people have already been killed in the air attacks. Hundreds of residents have been injured. And the inhabitants know that every walk, every visit to the market, every journey to the post office could be their last. This life in the crosshairs manipulates the psyche of the people. "The drones over our city are like the Angel of Death," explains local shopkeeper Nazeer Gul. "Only they know when and where they will attack and which lives they will extinguish."

Only the quiet hum in the air gives any indication that they are there. None of the residents know whether the unmanned aeroplanes are just carrying out surveillance work, or are about to launch a deadly attack. It's this uncertainty, this fear that a drone could strike at any moment, that has granted the USA complete control over an entire city – without a single pair of boots on the ground in Miranshah.

The experiment has shown that the potential effects of drones are far greater than previously thought. Much more than just terrorist-killers, drones are suitable for use as psychological weapons — with their help an entire civilian population can be taken hostage.

As a result, other governments are now keen to take part in drone experiments – and to deploy armed drones in warzones.

HOW FAR DOES THIS EYE SEE?

Flying at an altitude of 20km, the RQ-4 drone can operate for up to 40 hours without stopping. It's capable of monitoring telephone conversations and movements on the ground. Around 40 of the aircraft are believed to be in operation, each capable of patrolling an area twice the size of Tasmania every 24 hours.

THE HISTORY OF DANGEROUS EXPERIMENTS

uch of today's science depends on the human experiments of vesteryear regardless of whether they were legal or not, or whether they were ethical or morally sanctioned. Torture doctors like Nazi physician Josef Mengele sacrificed the lives of thousands by carrying out inhumane experiments of negligible scientific value. The Angel Of Death was fascinated by the study of genes and operated on hundreds of sets of twins in Auschwitz, without using anaesthesia. Since the Stone Age, doctors have been experimenting, trickling poisons and antidotes into wounds and administering extremely dangerous substances to their victims. Some of these 'healers' were working purely for their own interests, but the very worst experiments actually took place directly or indirectly under the command of the authorities and governments of the time. World of Knowledge examines the most gruesome experiments in history...



1943

Auschwitz, Poland

For two years Josef Mengele carried out hideous experiments on concentration camp inmates in his role as a doctor at Auschwitz. The Angel Of Death operated on victims by removing their organs and limbs and implanting them in other people. Thousands died as a result of his barbaric experiments, which he documented in meticulous detail.





How do you expose a spy? That was the question CIA director Allan Dulles occupied himself with. Since the end of the Second World War, America's relationship with the Soviet Union had been steadily deteriorating. In 1953 **Dulles ordered a secret research** project under the codename MKUltra. Scientists were tasked with developing a truth serum that would make enemy agents reveal all. For more than 20 years, they injected thousands of unsuspecting test subjects with drugs, with little success. Some even died during the process.



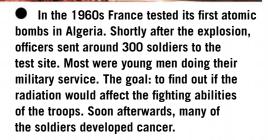
1955

♥ Edgewood, USA

"Sometimes it was an injection, other times a pill," remarked Tim Josephs, one of 100,000 US soldiers who volunteered for 'medical experiments', little knowing that these would include a veritable witches' brew of drugs – and even chemical weapons. The tests lasted until 1975, and some victims continue to suffer the consequences today.



♥ Algeria





1961

♥Worldwide

From 1958 to 1961, a wave of disabled babies were born in the UK. At least 10,000 children were affected worldwide – 470 of whom are still living today. Born with deformed arms and legs, their defects were caused by thalidomide, an anti-morning sickness pill seen as safe at the time. Since then, the approval of new medicines has been radically tightened.



1971

Stanford, USA

As part of the Stanford Prison Experiment several US psychologists re-enacted everyday prison life with volunteers. But the situation between 'guards' and 'inmates' quickly escalated and cases of sadism became frequent. Some participants broke down with stress. The study ended prematurely, but it was considered a milestone in social research.

TECHNOLOGY SCAN PAGE WITH FREE VIEWA APP TO WATCH THE MOST SPECTACULAR FIGHTER-JET FLY-BYS. AND MORE! viewa FLIGHT ARMOUR Ground fire from 23mm-calibre anti-aircraft guns strikes the A-10. But even with the loss of half a wing, a pitch elevator, the hydraulics and an engine, the machine is still capable of flying. DECOY FLARES The heat emitted by engines leads infrared anti-aircraft missiles to their target, so the A-10 throws out decoy flares when it is attacked: these then send the incoming missiles in the wrong direction.

incoming missiles in the wrong direction.

THE IMPORTAL FIGHER

The Fairchild Republic A-10 is ugly, slow and ancient – yet it still manages to outshine all of the US Air Force's other strike jets. While the newest high-tech aircraft are struggling to cope with the adversities of the desert, this airborne tank is really coming into its own again



TARGET SENSOR

The Pave Penny laser sensor can spot a laser-marked target from a distance of almost 30km. The system projects the result directly onto the cockpit glass so the pilot can't miss it. They only need to pull the trigger and hit the target.

he US infantry find themselves in the middle of their worst nightmare in Afghanistan: their wrecked convoy is pinned down – fire rattles in from every side. The soldiers press themselves against their armoured vehicles while their panicked officer calls in air support. But where is the enemy? One thing is clear: the deadly rattle of a dangerous weapon is coming closer and closer – a few more metres and the Americans will be in the grenade launcher's range. "Danger close," the commander shouts over the radio. For the pilots of the two Fairchild Republic A-10s, these words mean: strike, immediately – even if taking out the enemy means potentially killing their own men.

HOW DO YOU FIRE 4,200 TIMES PER MINUTE?

The advancing Taliban know nothing of the avalanche that is about to engulf them as Captain Michael Soleman* brings his A-10 in at an angle of 30 degrees. He's searching for clouds of smoke. "Even today, with all our high-tech gadgets, we rely on our eyes. Sometimes it's simply too late for smart bombs and surgical procedures," he says calmly. At an altitude of just 20 metres, Soleman races towards the enemy, who are only 50 metres away from the convoy. His timing is impeccable: Soleman pulls the trigger of the GAU-8/A Avenger, the largest, heaviest and most powerful on-board cannon ever carried by a jet. In theory, the seven rotating barrels can fire a staggering 4,200 shots

* Name has been changed.



The cockpit hood is not just bulletproof, it can even withstand a 20mm projectile. Beneath the cockpit, half a ton of titanium offers the pilot protection against even larger missiles.

HELLFIRE

The on-board cannon of the A-10 is placed slightly off-centre at the front. The reason: the seven barrels of the GAU-8/A Avenger rotate and always fire at a nine o'clock position, which is slap-bang on the aircraft's centre line.

per minute. But in practice, a short burst lasting just one to two seconds is enough to disable even the most heavily armoured target.

"It's ugly, it's lumbering and it's old. But the A-10 Warthog almost certainly remains the best performing airplane in the Air Force's fleet," says US military expert Jeffrey St. Clair.

With their final attack, the two aircraft destroyed the Taliban's convoy in a matter of minutes. The enemy fire was silenced – and all 60 US soldiers on the ground survived the skirmish. For the 'Warthogs' – as they're known, because of their brutal firepower and resilience – this mission against the Taliban was merely a chance to flex their muscles. The planes were designed with other battles in mind. "No vehicle in the world is safe from this monster," says an infantryman involved in the conflict.

Anyone unlucky enough to find themselves in the A-10's line of fire will have no idea what hits them. This is because each of the 70 bullets it fires every second travels at a speed of 1,000 metres per second. A single hit can trigger an inferno: the projectiles, which weigh almost half a kilogram and are made of extremely dense uranium, produce a



TANK DESTROYER

During the First Gulf War, the USA's A-10s destroyed Iraqi tanks with such speed that the vehicles often didn't even have time to get into their firing positions. The T-72, the world's most frequently deployed tank with a price tag of over \$1 million, had no chance against the A-10s' cannon – despite being clad in a metre-thick layer of the strongest steel and synthetics.



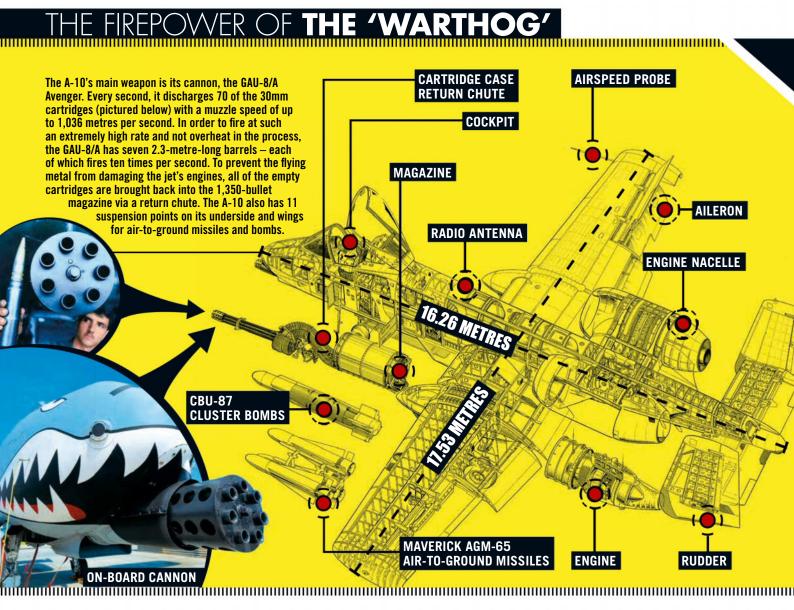


cloud of dust that ignites upon contact and can cause what's known as a secondary explosion.

WHY CAN'T THE A-10 BE RETIRED?

"No other jet has more firepower," says Captain Soleman. The recoil of the cannon is so strong that it actually causes the already lumbering machine to decelerate. If it was fired continuously, the A-10 would fall out of the sky unless some sort of countermeasures were deployed. These include the pilot following a precise sequence when firing the wingmounted auxiliary weapons, as a slight shift in gravity

would cause the recoil of the weapon to push the plane's nose to the side. After 17 seconds of fire, the Warthog would have hurled half a ton of deadly ordnance at its opponent. The A-10 is unique among the world's fighter planes: engineers developed the on-board cannon first - and only later considered how they were actually going to get the six-metre weapon, the size of a small truck, into the air. "Since the first Gulf War, the A-10 has outperformed every other aircraft even though the Stealth fighter got all the hype," St. Clair explains. In its greatest mission against Saddam Hussein in 1990-1991,



144 aircraft destroyed 4,000 targets during 9,000 sorties on the front. The A-10 accounted for more than half of the 1,700 Iraqi tanks taken out by air strikes. Only six planes were lost and their success rate far exceeded that of faster, higher-specification and considerably more expensive competitors like the F-15 Eagle or the F-16 Flying Falcon. Why? Even though the A-10's speed is just 800km/h – a snail's pace for a fighter jet – it is almost impossible to blast this flying tank out of the sky.

No other aircraft in the US Air Force can withstand more: the Warthog can even survive a missile strike under certain circumstances, thanks to its half-ton, titanium-armoured cockpit. Its self-sealing fuel tank is protected by internal and external foam layers. Meanwhile, the two engines are as far apart as possible, minimising the possibility of a simultaneous failure in the event of a rear impact. On top of all this, the pilot can also fall back on three on-board fire-extinguishing systems. Some Warthogs have made

it back to base with shredded wings, bullet-riddled fuselage and broken hydraulics. Even the glass cockpit hood can withstand 20mm gunfire. The F-35 – the most expensive plane in history and a potential successor to the A-10 – can be shot down by a Kalashnikov.

"The Air Force wouldn't allow the F-16 to fly below 3,000 metres because of its vulnerability to attack from anti-aircraft guns and missiles," admits military expert Robert Coram. The US military is having a tough time convincing critics of the F-35 that the costly jet can perform the close air support for ground troops that is the A-10's main strength.

The simple brute force of the A-10 does not automatically fit into a modern, state-of-the-art air force, which is why the military has wanted to scrap the fleet for years. But the US Congress is yet to be convinced by the alternatives and has blocked the US Air Force's plans to scrap it. The Warthog is so enduring, even its own commanders can't put it out of action.



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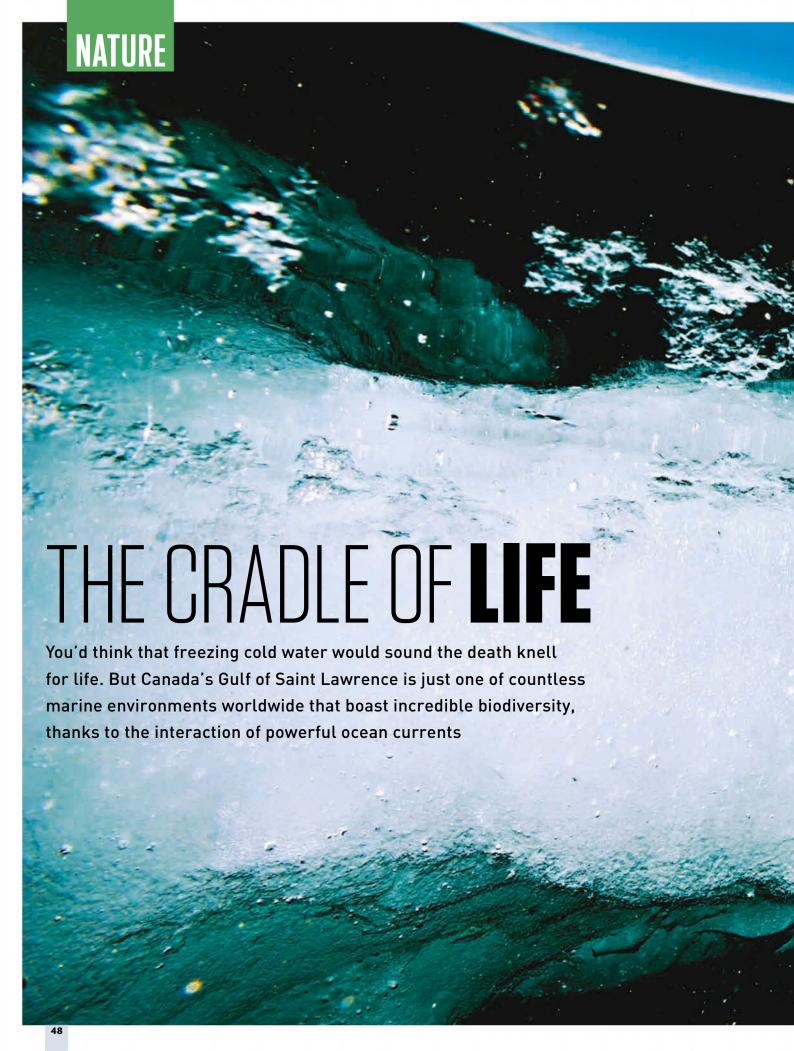
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t sits calmly on the gravelly river bed, as if it has all the time in the world. A row of sharp teeth glint between the drooping corners of its surly-looking mouth. But it doesn't have these teeth because it's a wild hunting beast - even if its name, the Atlantic wolffish, does tend to suggest a predatory personality. Instead, the wolffish needs them to chomp on the mussels and crustaceans that form the basis of its diet. And these are found in abundance here. lying motionless like the wolffish, filling their own stomachs with the smallest organisms in the ocean: plankton. Some areas are ideally suited to animal life. The immense Saint Lawrence River, a water highway that marks the entrance to North America, is one such region. It's a place where everything fits together, where extremely complex natural processes converge. A place that not only benefits life, but causes it to explode spectacularly.

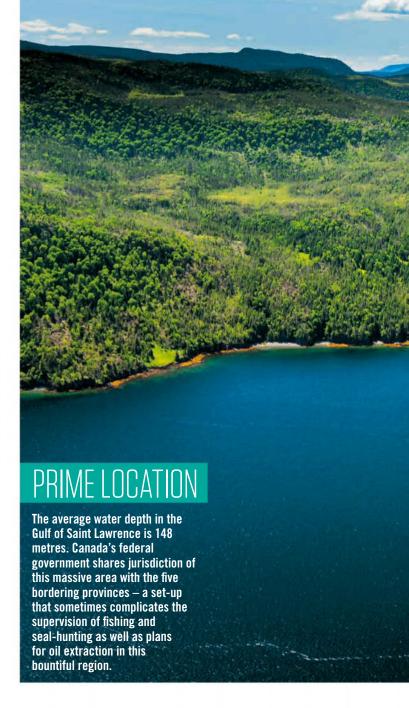
IS IT A RIVER OR SEA?

First off, what should we call the Saint Lawrence River? Is it a river, a sprawling delta or some kind of sea? All three are correct or, at least, not incorrect. The Saint Lawrence River is a unique waterway that travels 3,000 kilometres from its source in Minnesota, where it is still called the North River, to its mouth. On its journey the river cuts across the Great Lakes and forms 150 kilometres of the border between the USA and Canada before flowing north-eastwards.

Hydrologists divide the Saint Lawrence River into four sections. The fluvial section encompasses the course of the river from its outlet into Lake Ontario - the point from which the river carries the name 'Saint Lawrence' - until Quebec. From there the fluvial estuary section begins, marking the first part of the estuary zone. Cloudy brackish water and marshlands characterise this part, which is home to thousands of waterfowl, eel, trout and other breeds of fish. The nearer you get to the river's mouth, the saltier the water becomes. In the upper estuary section, marine mammals like beluga whales and seals can be found alongside saltwater fish. The lower estuary and the Gulf represent a saltwater paradise for cod, halibut, flounder and salmon as well as the large cetaceans. Shortly before it empties into the Atlantic, the river is over 145 kilometres wide.

WHAT BOOSTS NEW LIFE?

Any explanation of the Gulf's boundless fertility begins with a familiar concept: water is constantly in motion. And not all H_2O is created equal. If you were to sail to



the eastern side of Cape Breton island (a spit of land at the entrance to the Gulf of Saint Lawrence), you'd feel the cold, windy currents of the Atlantic thrusting themselves against the shore. On the western side, however, the water is calmer, a few degrees warmer – and much more fertile. Here our wolffish munches on shellfish in peace, and shares its habitat with thousands of other species in what biologists call an 'ecologically significant' region. These areas exist worldwide, particularly in coastal regions – or so-called upwelling zones.

Upwelling systems are shaped by the interaction of three natural forces: the powerful currents that cross the world's oceans like giant conveyor belts, the power of the wind and the Earth's rotation. How does this work in practice? Ocean currents



allow cold water in the polar regions to sink to great depths and flow towards the equator. This water can remain there for centuries, gathering valuable nutrients from marine organisms that sink into the depths when they die. The water becomes so rich in nutrients, it could practically be used as compost in even the most barren desert.

So what is the best fertiliser in the sea used for if there are no plants that need cultivating? This is where the wind comes into play. When wind blows along the sea, it displaces the water on the ocean's surface. The Earth's rotation also causes water to be displaced: a force known as the Coriolis effect steers ocean currents to the right in the northern hemisphere, and to the left in the southern hemisphere – so the water



upstream through the cloudy water. Its scars are a result of brawls

with other males.

shifted by the wind is transported through the oceans and around the globe in a spiral motion, making room for cold water from the deep to rise upwards. When water from beneath upwells, vital nutrients are swept back to the surface where they're needed most. The water at the top becomes enriched with oxygen, fuelling vast blooms of phytoplankton – tiny algal cells which form the basis of the food chain. These are then consumed by swarms of krill, themselves the favourite food of marine mammals like whales. A paradise for life develops.

Stable wind systems like the trade winds in the southern hemisphere also generate upwelling systems close to the equator. The Humboldt Current off the coast of Chile has created one of the most fertile marine ecosystems in the world. Its cold water has a cooling effect on the climate of the neighbouring Atacama desert, one of the driest regions in the world. But just a few kilometres away, its nutrient-rich waters see to it that all breeds of life are thriving.

And the Saint Lawrence River? It also forms a small part of this global conveyor belt. The river abuts the icy Labrador Current, which usually flows at a depth of 300 metres in the opposite direction. But at the entrance to the estuary, upwelling forces ensure that the cold, nutrient-rich water rises upwards and mixes with the surface water. During this vast mixing process, the Labrador Current incorporates a large amount of water from the river, which it then transports from the tip of Newfoundland to the warm Gulf stream, which in turn flows towards Europe and influences the climate.

In several decades, it's likely that drops of the same water in which the wolffish waited calmly for its prey, will wash up on beaches thousands of kilometres away.

IDEAL CONDITIONS FOR LIFE

orth America's third-largest river, the Saint Lawrence River, connects the Great Lakes to the Atlantic Ocean. For around 1200 kilometres, it flows under this name as a river, before progressing into a 660-kilometre-long funnel-shaped estuary opening into the Gulf of Saint Lawrence. There, across an area of 235,000 square kilometres, nutrient-rich Atlantic saltwater mixes with freshwater from the river. In this massive body of water, an incredible variety of life forms have developed.



SAINT LAWRENCE RIVER On their journey

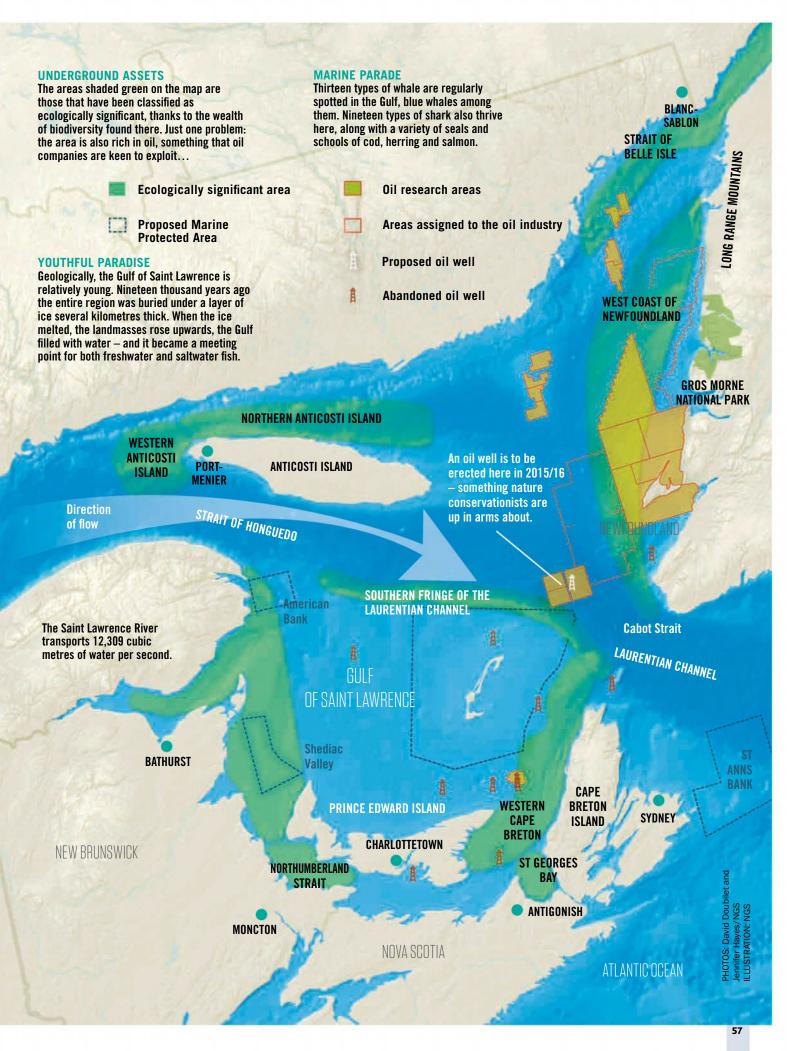
On their journey northwards, the water currents – which can reach speeds of 11km/h – become colder and colder. Then suddenly, close to the Arctic Circle, they fall to depths of 3,000 metres: a gigantic waterfall in the middle of the ocean.

FERTILE CURRENT

The cold deep current eventually flows along the coast of America and then south again, reaching the surface in upwelling zones along with its nutrient-rich cargo.

HIGHWAY TO THE NORTH

For millions of marine creatures, including whales, rays and dolphins, the large band of current in the Atlantic is the most important 'motorway' in the sea.



HUMAN BODY For years, interpreting dreams was the realm of psychologists. But now neuroscience is using state-of-the-art imaging technology to make spectacular new breakthroughs. It seems dreams are capable of revealing unexpected information about our bodies and our minds 58



e a h lir T a s c c fi

enneth Parks was clearly not all there when he stabbed his mother-in-law to death. In fact, he was asleep. Though this might sound absurd, it's really quite simple. It appears that the Canadian man, who suffered from long-term insomnia and was experiencing severe

stress at the time of the crime, wasn't awake for the entire ordeal. He even drove his car to the scene of the crime in this condition. When he finally awoke, it was too late: the first thing Parks consciously remembers is looking into his victim's terrified eyes. He experienced everything else in a dreamlike state. But Parks couldn't have been dreaming – could he?

Neurological examinations in a sleep laboratory showed that his sleep patterns were highly irregular: although his sleep was deep, it was also very unstable certain parts of his brain were awake while others were in deep-sleep mode. The neurologists concluded that his brain functions were operating independently of one another. He retained control over his motor function, which meant he was able to move and could commit the bloody crime. His consciousness, however, was operating in a sphere that healthy people experience from the safety of their beds, in a paralysed state - in the world of dreams. Given the neurological evidence, Parks was not found to be responsible for his actions and was acquitted of the crime. This extreme case shows the powerful and complex impact of our dream worlds.

Using state-of-the-art measuring techniques, scientists are now making pioneering discoveries about dreams that have the potential to change our lives. Experts at the University of Montreal compiled thousands of dream reports and gathered them in a huge 'dream database': a unique collection of messages that our subconscious - the part of our personality hidden to us in waking life - reveals to us during sleep. After all, that's exactly what dreams are: the sole means of communication open to a hidden part of ourselves, one that knows more about our mind and body than we'd care to admit. But dreams can be difficult to decipher - and if we aren't even aware of what our dreams are trying to tell us, they'll never make sense. Even though Parks' case shows dreams can sometimes be a matter of life and death...

15 QUESTIONS ABOUT MY DREAMS

15 FASCINATING ANSWERS FROM NEUROSCIENTISTS

For decades, the scientific world dismissed dreams as insignificant. However, as a result of studies on the brain, research into our dreams is experiencing one breakthrough after another.

HOW DOES THE BRAIN CREATE NEW WORLDS?

Suddenly we're floating, the world around us seems to stand still, except for that pink elephant calmly floating above us. Scenarios like these are the dream worlds we inhabit at night – a pretty incredible performance put on by the brain! Even the smallest of details are simulated by the imagination, created entirely by our brains but experienced as though they were real. Neuroscientists have discovered that our minds release large amounts of dopamine as we dream – the same hormone that makes us alert and productive. That actually makes a lot of sense: during sleep our bodies are paralysed and cut off from the real world – making us hunger for the impressions of our dream world. And dreams enable this experience through dopamine: "It lets you do almost anything you want," says dream scientist Mark Solms.

(2) CAN DREAMS BE UNHEALTHY?

Have you ever woken up from a dream with a start and looked around in a confused state, before falling asleep again? Then you've experienced first-hand what REM (Rapid Eye Movement) sleep is all about. This phase of sleep is becoming increasingly important in neuroscience as most dreaming takes place during it. Blood pressure, breathing rate and heart rate increase during REM sleep - it's pure physical stress, about as strenuous as cycling uphill. If you have heart problems, your risk of a heart attack is highest during REM sleep. This phase also stimulates the amygdala, the brain's fear centre. It's the only phase in which nightmares occur: and the longer we sleep, the more REM phases we have. So it might be better not to sleep in - what seems relaxing can quickly turn into fatigue or even depression (the risk of both is increased in people who have regular nightmares).



CAN AN MRI SCAN READ OUR DREAMS?

How does your brain recognise faces? And could we reconstruct this facial recognition using neuronal signals? Would it be possible to reconstruct dreams in real images? Possibly - if we first compiled a kind of dictionary that catalogued these signals. Neuroscientist Alan Cowen showed six test subjects pictures of 300 faces as they lay in an MRI machine. While they looked at the pictures, the machine analysed how the participants' brains reacted to different facial features, creating a dataset of neuronal patterns. Afterwards, they showed the test subjects different faces. The data they'd already collected helped them to reconstruct what was seen - the top row shows the original faces, while the bottom shows the images reconstructed by the scanner using only the data from the brain.

DOES THE BRAIN HAVE ITS OVEN TWILIGHT ZONE?

When exactly did you fall asleep last night? You don't remember when you crossed the line between being awake and dreaming, do you? Or how long it took? That's hardly surprising: like a submarine sinking slowly underwater and losing contact with the surface only in gradual increments, your brain does not switch off all connections to the waking world in one go when you fall asleep. Our sensory signals converge in the thalamus, which relays them to the cerebrum - the seat of human consciousness. That's why neuroscientists describe the thalamus as the 'door to consciousness'. But when we fall asleep, the thalamus is deactivated before the cerebrum. This disparity leads to hallucinations that are not yet real dreams. According to Michel Magnin, a French neurophysiologist, these hallucinations are misinterpretations of certain signals that the brain is unable to decipher without the help of the thalamus. Neuroscientists call this state hypnagogia. You think you can hear someone screaming or see strange static images. When you wake up, however, the various parts of the brain immediately start working in tandem again.

DO DREAMS KNOW ABOUT YOUR BODY?

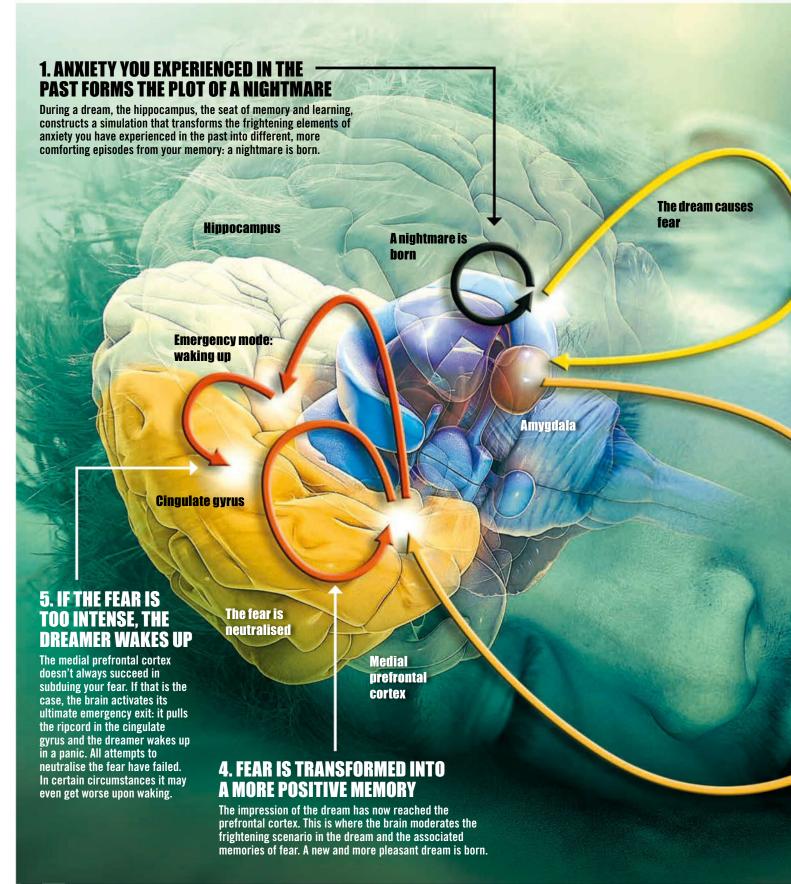
The night brain could be compared to an undiscovered terrain, one that scientists are only just beginning to map. What does it mean when we dream about illness? We haven't experienced any pain or other symptoms, but the illness has already begun to develop. Does our dreaming self know something we don't? Several reports suggest that your dreams may give you information about your body's condition. US surgeon Bernie Siegel had a patient who had recurring dreams about being tortured by a man holding hot coals under his chin. Tests revealed he had thyroid cancer. "Dreams can be like x-rays in some cases," says dream expert Dr Robert Van de Castle. Scientists are not sure why, but they have identified one sure warning sign: if your dreams suddenly take a violent turn and you regularly dream about fighting off an attacker, you are more likely to develop certain neurodegenerative illnesses, like Parkinson's, in one or two decades. In many cases these dreams are the first signs of a condition that can take years to develop and be diagnosed. This perplexing phenomenon is called RBD (Rapid Eye Movement Sleep Behaviour Disorder).

(6)

CAN YOUR BRAIN

CONQUER A NIGHTMARE?

Sometimes you feel distressed when you wake up. You know you must have dreamed about something unpleasant, but you can't pinpoint exactly what it was – whatever image you found frightening has already disappeared. After years of neurological dream



research, Canadian psychologist Tore Nielsen has reached a fascinating conclusion: your brain acts like a fear censor every night, working to protect you from your worst dream memories. Using his discoveries, Nielsen has developed the first ever neuropsychological model of nightmares.



(7) CAN FOOD CAUSE NIGHTMARES?

Dream sleep is subject to the same physical influences as our waking life. For this reason, even things as banal as food can have an unforeseen impact on the dreaming mind. When metabolism increases, perhaps because the body is busy digesting particularly spicy or heavy foods, our sleep rhythms can be directly affected. As the REM phase becomes more active, our dreams become more intense – nightmares included. "It might be that some people are particularly sensitive to the chemical composition of certain foods," says Tore Nielsen, who specialises in nightmares.

WHAT DOES IT MEAN IF YOUR PARTNER IS IN YOUR DREAM?

Over the course of human history, we've developed certain patterns in the brain to help us pick the right partner. A previously unknown fact: dreams are very important in this process, acting like a supervisor with surprisingly accurate insight – generally more accurate than your own – into where your relationship stands. People who feel more connected to their other halves dream about them more often. For example, they might dream about their partners asking them for help. A US study found that in relationships that are already troubled, dreams about a partner's infidelity can sometimes provide the impetus to end the relationship. However, healthy relationships tend to cushion the negative impact of such dreamed emotions.

WHAT'S THE PURPOSE OF NIGHTMARES?

Dreaming about flying or falling, nightmares about the death of a loved one, frustrating dreams about being late for something, horrific visions of being attacked by a predator or drowning in a tsunami – today's evolutionary biologists agree that having these dreams

is an important method that the brain uses to simulate danger so that the dreamer will be better prepared for threatening situations when awake. Just like our forefathers before us, we dream about being chased by wolves – although we are unlikely to ever encounter a wolf in the wild. Finnish scientist Antti Revonsuo specialises in nightmares and is convinced that the mechanisms that enable us to practise stressful moments in our dreams stay with us throughout our lives. It isn't until we reach adulthood that we add modern-day horror scenarios to the wild animals of yore, like losing your wallet or having a car accident, for instance. Revonsuo even goes so far as to say, "Without nightmares and bad dreams, there's a good chance that humanity wouldn't be here today."

(10) WHAT DO RECURRING DREAMS MEAN?

It's time for his physics exam again and he knows he'll never pass. Stephen Browne feels like a primary school pupil in the running for a Nobel Prize. For many years, most neurobiologists believed that dreams developed by chance without following any recognisable pattern. Deriving a meaningful conclusion from a specific dream image or a recurring dream was considered esoteric nonsense. Today, however, neuroscientists recognise that recurring dreams are as universal as emotions. Billions of people are afraid of exams, which explains why this is one of the most common recurring dreams across the world. The fear takes root in your subconscious and keeps recurring as a common theme whenever you experience anxiety or stress. After all, what is the classic exam dream, if not the fear of turning up and failing? Scientists who research stress are convinced that this fear can keep reappearing throughout our lives.

DO DREAMS MAKE YOU SMARTER?

A lot of good ideas are hatched when you bring two things together that are otherwise unrelated. At first glance, it may seem that the urge to fasten your shoes as quickly as possible and the way that seeds get stuck to animal fur when they brush up against certain plants are two entirely different concepts. But taken together, they brought about the invention of Velcro. Creatively repurposing thoughts like this is something the brain also does when you dream – especially

during REM sleep. "During REM our brain areas start to really talk to each other a lot more. REM sleep seems to enhance memories that you do not consciously try to manipulate, such as your visual memories and your creativity," explains Sara Mednick, a sleep researcher from the University of California. Dreams also have another function: they sift through the memories of the past day looking for important new skills, before consolidating them in the long-term memory. In other words, sleep is a state in which the information that comes flooding in every day is converted into knowledge.

ARE GAMERS 'BETTER' WITH NIGHTMARES?

People who regularly play computer games appear to develop a specific skill that allows them to react more calmly to nightmares than non-gamers. It's a logical effect: in nightmares, as in a waking state, nothing frightens us more than losing control - one of the biggest stress factors known to man. But in computer games, the gamer always has absolute control. After speaking with dreamers, Canadian psychologist Jayne Gackenbach found that gamers who had dreams about being chased were more likely to defend themselves. The fear centre was much less active than the area of the brain responsible for tactical thinking - and seemingly the reward centre as well. "They say that they had a nightmare and it was great," the researcher explains, "and that they feel much stronger after the experience." Does this mean that gaming could prove ideal training for people dealing with agonising and traumatic nightmares?

DO DREAMS PROTECT YOUR FEELINGS?

US psychologist Rosalind D. Cartwright is convinced that dreaming is the brain's way of easing the severity of our daily worries and counteracting acute stress. "It's almost like having an internal therapist, because you associate [through dreams] to previous similar feelings, and you work through the emotion related to it so that it is reduced by morning," the psychologist says. In sleep studies of recently divorced women, Cartwright found that the women who could recall dreams involving their ex-husbands or their former relationships scored better on tests of mood in the morning. "It really shows that there was an ongoing working on the dream material through the night,



VVHAT ARE THE MOST COMMON DREAMS?

Canadian dream researcher Antonio Zadra surveyed more than 1,000 students to reveal the most common themes of their dreams. Certain dreams were mentioned again and again – apparently there is some kind of dream blueprint in our

brains that means people react similarly to everyday problems and fears in their dreams. The table below presents the top 12 dreams based on the responses from Zadra's test subjects – and how dream researchers interpret them.

81.5% EBEING CHASED

The dreamer is trying to run away from something — for dream experts this is a sign that they are also trying to avoid something when they are awake.

76.5% SEXUAL ELEMENTS

This is not necessarily a sign of sexual desire. In many cases, erotic dreams will reveal the truth about the dreamer's hidden feelings.

73.8% FALLING

Dreaming about falling is one of the most universal dream experiences. These dreams are symbolic of a fear of losing control or your foothold on life.

67.1% SCHOOL SITUATION

This dream is common and can be experienced by people at any age. The exam setting often symbolises hopelessness and a lack of confidence.

59.5% BEING LAT

Maybe you are perpetually pressed for time when you are awake? These dreams highlight frequent feelings of anxiety in waking life.

57.7% ABOUT TO FAL

A variation on the falling dream: the dreamer is able to avoid falling at the very last second. This is often a sign of insecurity about the future.

54.1% ERSON

The fear of losing a loved one is a common dream theme – and may be a sign of problems with that particular person.

53.5% FAILED ATTEMPT

To start the car or build a house of cards: if this theme is frequent in your dreams, it symbolises your fear of failing despite your best efforts.

48.3% FLYING

Or floating up in the air without any assistance
– an age-old dream of mankind! An expression of
freedom that may also signal a desire to escape.

48.3% FEELING A STRANGE PRESENCE

In your dream you're convinced there is somebody else in the room – this can hint to an unknown aspect of your personality.

45% FAILING AN EXAM

The questions are much too difficult and you are not prepared — the exam is a central symbol for our fear of failure.

42.4% BEING ATTACKED

In your dream, you're being physically injured – for dream experts this is a sign of feeling threatened, of being at someone else's mercy.

and eventually that the depression lifted in those people," Cartwright reasoned. When we are going through difficult times, dreams that remind us of pleasant past experiences can provide enormous emotional support and valuable consolation.

WHY DO SOME PEOPLE REMEMBER THEIR DREAMS?

Some people always remember their dreams when they wake up – much to the annoyance of people who can't! PET (Positron Emission Tomography) scans have shown that people who are good at remembering their dreams exhibit a significantly higher amount of activity in the prefrontal cortex and an area of the brain known as the temporoparietal junction – both when they are awake and when they are asleep. They also have a particularly sensitive reaction to sound. The French neurologist Perrine Ruby sees a close correlation between the two: in order to remember dreams, you must wake up occasionally – this is when the brain stores the information it has just received. People who are particularly sensitive to noise tend to wake up more often during the night – and are therefore more

likely to be able to remember the dream worlds they inhabited in the course of the past night when they awake the next morning. The notion of remembering dreams also has a fascinating historical dimension: while researching his book about the night, US historian Craig Koslofsky studied novels and diaries from the 17th and 18th centuries. In the process he found numerous references to the 'first sleep' and the 'second sleep'. For centuries, people slept in two blocks of around four hours each with about an hour awake in between. They spent this time relaxing by reading a book, praying or even thinking about their dreams. (And don't forget, during this period of history, before the invention of electricity, the night and the darkness that came with it were generally feared.) This period of wakefulness made it much less likely that they would forget their dreams and made dreams a normal part of daily life. In extensive sleep experiments, American scientist Thomas Wehr also found that his test subjects, who spent 14 hours in complete darkness every day for a month, automatically fell into the four-hour/onehour/four-hour sleeping pattern. It seems that sleeping through the night without being disturbed is not an entrenched law of nature. In fact, interrupted sleep may be more consistent with the natural sleep patterns of our ancestors than previously thought. W

SCIENCE

SUN

Compared to this monster star, our sun is a dwarf: around 35 of our suns placed side by side would fit into this supergiant. It also shines ten million times brighter than our sun: in the sky, our star would pale in comparison to R136a1 — just like the full moon next to the sun.

R136a1

Around 265 times heavier than the sun, at birth as much as 320 solar masses — in theory, this star shouldn't even exist. For years, astronomers thought that it would be impossible for a star to reach this mass. The blue glow comes from its high surface temperature: at 50,000 degrees Celsius, it is eight times hotter than the sun. The hotter a star is, the bluer it shines, while relatively cool stars have a red glow.



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STARS IN THE
UNIVERSE.
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HOW DO YOU WEIGH A STAR?

Our sun weighs about two octillion tons — that's a figure with 27 zeros — or roughly 330,000 times the mass of the Earth. Astronomers use this as a benchmark for other stars: ten solar masses, for instance, means that a star is ten times as heavy as our sun.

EARTH

R136a1 weighs around 300 million times more than the Earth. If this star replaced our sun, its diameter would exceed the distance of the Earth's orbit. In order for our planet to escape the star's enormous gravity, it would have to move at seventeen times its current speed — so instead of orbiting the sun in one year, it would take just three weeks.

Until recently, astronomers believed that the upper limit for stellar mass was around 150 times that of our sun.

Then scientists discovered the largest star ever found, a true supergiant that appears to double that number

aul Crowther can't believe his eyes. The British astrophysicist has gone over the data countless times. The Large Magellanic Cloud, a nearby galaxy and satellite to our Milky Way, appears to be harbouring a monster star.

Did Professor Crowther just make a sensational discovery? There seems to be no doubt: the star – R136a1 – does indeed weigh 265 times as much as our sun and far more than any star ever previously discovered. But that means its mass is higher than theoretical physics allows. A supergiant of this size just shouldn't be able to exist...

WHAT CATASTROPHE BROUGHT THIS MONSTER STAR TO LIFE?

"R136a1 raises the maximum possible mass for stars by a factor of two," explains astrophysicist Olivier Schnurr from the Leibniz Institute for Astrophysics in Potsdam, Germany. "We have to come up with an entirely new scale." And there's more: calculations indicate that the supergiant weighed even more – about 320 solar masses – at birth.

This evidence destroys one of the long-standing theoretical constructs in physics. About 1.4 quintillion kilometres (NB: a quintillion is 1 followed by 18 zeros) from our planet there is a star that weighs almost 300 million times more than the Earth. Measured in tons, that's a number with 29 zeros.

But what kind of cosmic catastrophe would it take to create such a colossal star? The easiest way to answer that question is to look at how stars are born. They're created when huge clouds of gas and dust collapse under their own gravity. The growing pressure increases the temperature, like compressed air inside an air pump. When it reaches a specific mass, it will be hot enough to ignite a virtually endless source of energy – nuclear fusion – and a star is born. Our sun went through this very process.

But why wouldn't a star just keep on growing indefinitely? After all, it keeps 'sucking in' gas particles from its surroundings, all of which makes the star stronger and hotter. But this is precisely what will be the star's undoing in the end: at a mass of about 150 solar masses, the star releases so much energy into its surroundings that its gravity is no longer sufficient to attract new 'fuel' - it literally blows it away. In other words, it has achieved the maximum possible mass. At least that is what was believed until now.

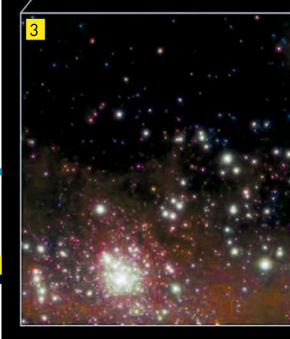
Astronomers can only speculate as to how R136a1 was formed. The most likely scenario is through an immense cosmic collision of numerous giant stars, and there's evidence to support this hypothesis. Within a small area around R136a1 there are other supermassive giants with a birth weight of around 150 solar masses. "Although extremely complicated physics is involved when two very massive stars collide, we still find it makes a convincing case for the monster stars seen here," explains astronomer Sambaran Banerjee.



SAMBARAN BANJEREE Astronomer, University of Bonn







//// THE HOMELAND OF THE SUPERGIANT /////

t a distance of some 1.4 quintillion kilometres, the A Magellanic Cloud (1) is considered a neighbouring galaxy to our Milky Way. On the Earth's Southern Hemisphere, we can even see its stars with the naked eye as a blurry cloud. The Tarantula Nebula (2) is one of the

most productive star factories in the universe. It is also the native galaxy of the R136 star cluster (3), with R136a1 as its biggest star. You can see it in the bright spot on the lower left quarter of the image. This cluster contains approximately 100,000 stars.

ARE THERE 'IMPOSTER' **STARS?**

Wouldn't it be possible for more stars to simply unite and make an even bigger super-supergiant? Probably not, due to the so-called Eddington Limit which describes the largest possible amount of energy that can be forced from the centre of a star into space. At about 300 solar masses, the structure becomes as unstable as a balloon that has been filled with too much air. The internal pressure grows so great that the star inflates and sends its outer layers spilling into space.

A similar phenomenon can currently be seen in our Milky Way: the star VY Canis Majoris has a radius that is 2,000 times larger than our sun - R136a1's radius is only 35 times as large - but there is nothing but 'hot air' behind it. This red hypergiant is in the final throes of death and has puffed up its meagre 20 solar masses as the end nears.

DOES THE UNIVERSE HAVE A LIGHTHOUSE?

Compared with the Earth, our sun seems huge. But for astronomers, it falls into the category of a yellow dwarf - luckily for us. It seems that the larger a star is, the shorter its life and therefore the less time there is for life to form on any planets around it. The giant not only burns more fuel per time unit, it also sends huge pieces of its outer mantle into space thanks to the enormous pressure coming from its core. "Being a little over a million years old, the extreme star R136a1 is already 'middle-aged'," Crowther

explains. This is the same stage our sun is in - but after four billion years on the clock.

If R136a1 were to replace our sun, the Earth would scrape up against its visible surface. To make sure the supergiant doesn't swallow it up, our home planet would have to drastically increase its orbital period: instead of one year, it would only have three weeks to travel the same distance.

But it would never come to that: with a surface temperature of 50,000°C - compared to our sun's temperate 6,000°C - R136a1 would vaporise the Earth on the spot. "It would bathe the Earth in incredibly intense ultraviolet radiation,

"The largest stars
only live three million a reliable source of energy for the Earth for another ten billion years of so, R136a1 is likely to die off much sooner: "The largest stars only live three million years, which is a pretion of the largest stars only live three million years, which is a pretion of the largest stars only live three million years, which is a pretion of the largest stars only live three million years, which is a pretion of the largest stars only live three million years, which is a pretion of the largest stars only live three million years, which is a pretion of the largest stars only live three million years, which is a pretion of the largest stars only live three million years, which is a pretion of the largest stars only live three million years of the largest stars only live three million years. astronomical terms."

PAUL CROWTHER,

Professor for Astrophysics at the University of Sheffield

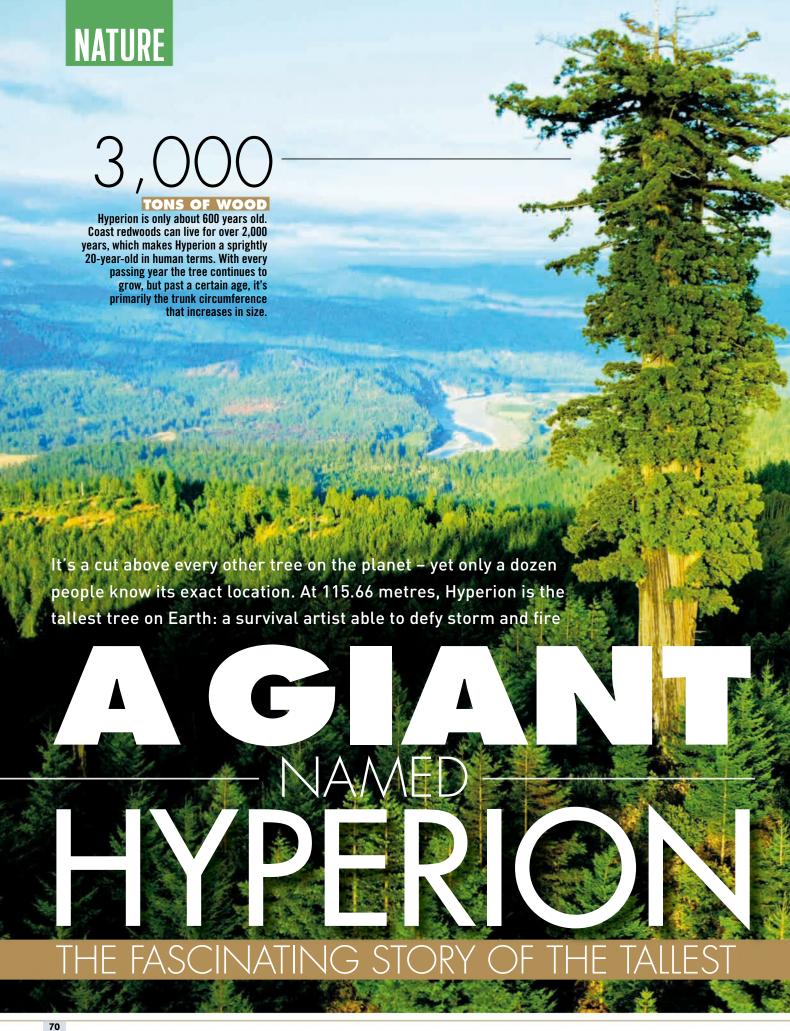
rendering life here impossible," says astrophysicist Raphael Hirschi from Keele University. The Earth would have to be at least 370 billion kilometres from its new giant sun for life to be able to develop. That is 2,500 times further away from the central star than we are now, and about 83 times the distance at which Neptune, the furthest planet in our solar system, orbits the sun.

The luminosity of R136a1 is almost unbelievable; no star yet discovered is brighter. It shines ten million times brighter than the sun. That means this supergiant would outshine our sun about as much as the sun outshines the full moon. And instead of a circular disc. we would only see a blurry cloud in the sky, since the pressure coming from its core is constantly causing huge chunks from the surface to break off into space. Our familiar yellow sun would also be a thing of the past: at around 20,000°C surface temperature, stars start to glow blue, while a bright red colour indicates that the temperature is below 4,000°C.

HOW DOES A MONSTER STAR DIE?

Earth for another ten billion years or so, R136a1 is likely to die off much sooner: "The largest stars only live three million years, which is a pretty short time in astronomical terms," Paul Crowther explains.

The finale is bound to be as intense as its short life: when the fuel supply starts to get low, the star rips apart in a massive explosion that will be about 100 times stronger than a supernova. And even the smallest of these supernova explosions are considered to be the biggest energy bursts in the universe. "A monster star like R136a1 is extremely rare," Paul Crowther says. "I doubt we will find a bigger one any time soon." Maybe so, but it wouldn't be the first time that reality sets the physicists straight. W



DOLLARS FOR A WONDER OF THE WORLD Inday only five nor cost of the

Today, only five per cent of the original old-growth coast redwood forest remains. The wood is of such a high quality that it was chopped down to make furniture. But since 1920, these trees have been protected in national parks. Hyperion's timber is valued at roughly \$100,000. But among scientists and conservationists, the wooden giant is considered priceless.

-20

Redwoods (also known as seguoia trees) are almost completely impervious to insects, rot and fungi. Even fires can barely damage them. They have one weak point: frost. Below minus 20 degrees Celsius, the water stored in the trunk freezes and obstructs the supply to the crown the tree then dies from the top down.

ABSOLUTE SECREC

There are hardly any photos of Hyperion – and even those that do exist give little indication of the coast redwood's location. To even get close to its habitat, you'd have to hike through the undergrowth for seven hours.

tephen Sillett draws his crossbow. The biologist from the Institute for Redwood Ecology in California takes aim and releases. With a soft hum, the bolt shoots upwards. Thirty metres, 40 metres, 50 metres. Sillett loses sight of the projectile almost instantly, but the whirring

of the spool of thread on the crossbow tells him that the bolt, connected to the bow by strong fishing twine, is racing its way up to the treetop. Suddenly the reel stops. It pauses momentarily before beginning to spin again. Sillett smiles: a perfect shot. The bolt flew over the first branches and is now falling back to the ground. These branches start growing about 50 metres up from the bottom of the trunk, which is thick like a titan's arm.

AN OF THE FOREST

They reach heights of more than 100 metres, while their trunks can have a circumference of up to 30 metres. And redwoods can live to be thousands of years old...

hey often spread their seeds only when the surrounding competition has been burnt down. drop, this water freezes. But the water-laden trunk is also an advantage as it makes the The reason? The bark is soaked through with water, like a sponge. When temperatures These trees can rarely cope with temperatures below minus 20 degrees Celsius. rees extremely resistant to fire. In fact, redwoods almost look forward to forest fires: ry winds, salty soil and cold temperatures are the redwood's natural enemies.

SEGREGATION

female seeds in pinecones – but on Redwoods carry both male and separate branches. The seeds are pollinated on the wind by nale pollen.

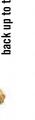
The coast redwood Hyperion belongs to the cypress family as do its close relatives, the giant sequoia trees. They are one of the oldest plant species in the world.

seeds. But only a dozen of A cone contains up to 60 SEED DUMMI

distinguishing the bad seeds rest are empty shells. It's a deter predators, who have hese are germinable, the aloy that redwoods use to rom the nutritious ones. the laborious task of

he needles evaporates is created, drawing the on them, the liquid in As a result a vacuum water from the roots When the sun shines titans' engine room. The leaves are the

back up to the crown.



WHERE DO THE TITANS CALL HOME?

with enough rainfall. Coast redwoods like Hyperion like it even damper and This location is ideal: not too hot in summer, not too cold in winter – and ant redwoods grow on the western slopes of the Sierra Nevada in northern California, in the Sequoia & King's Canyon National Park. prefer the foggy, rainy regions close to the Pacific.

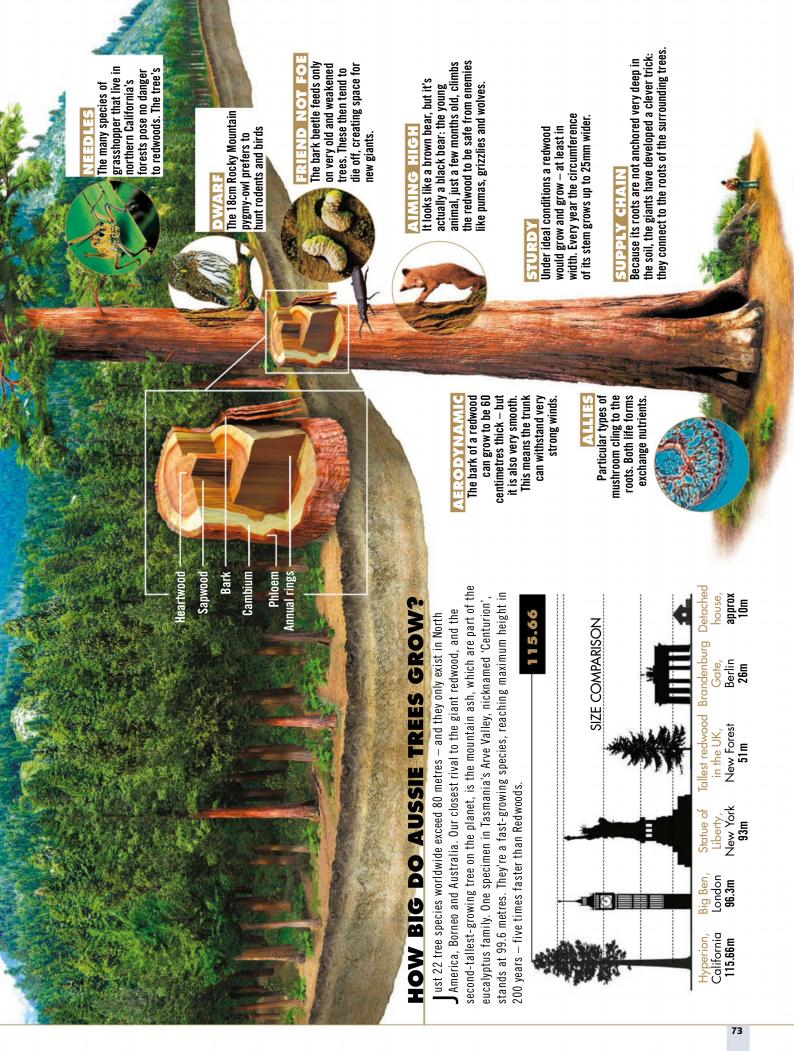
share the branches with insect residents on every floor. A few dozen plant species exist only on the trunk and branches of redwoods. These plants also hey are the skyscrapers of colonies, birds and rodents. the forest – with countless

old trees. Its wingspan can measure up to 2.5 metres. staggering 450kg) on tall, he American bald eagle prefers to build its nests (which can weigh a

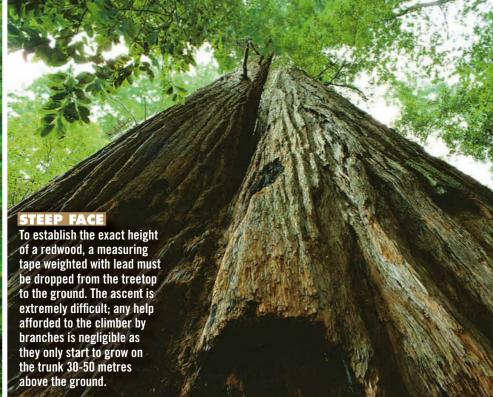
So it feels right at home among old-growth forests where trees The 40cm spotted owl prefers are more than 200 years old. the coast redwoods.

world and sometimes inhabits The Douglas squirrel is one of the best climbers in the deserted bird nests in the treetops.

damage: the giant's bark is very tough and the germs are only able to infect small superficial areas of the tree. **Grey mould occasionally afflicts** redwoods. But it can't do much







"When you climb to the crown of a redwood, you find yourself in a completely foreign world." Stephen Sillett, Institute for Redwood Ecology

Professor Stephen Sillett stands at the foot of this giant. The trunk's average circumference is 4.6 metres.

Hyperion was discovered by hikers Chris Atkins and Michael Taylor in 2006: they named the tree after the titan from Greek mythology, whose name means 'watcher from above'. At the time they used a laser to measure it. The result? Roughly 115 metres, a world record, the tallest tree on Earth.

But even the best laser would not be able to record the exact height of the tree from the ground. Someone needed to climb to the top. Using the arrow to set a climbing line and ascending using safety ropes and pulleys, someone would have to throw down a rope weighted with lead once they reached the crown. And that someone is Stephen Sillett.

ASCENT INTO A FOREIGN WORLD

Hyperion is a coast redwood (*Sequoia sempervirens*), a giant evergreen native only to north-eastern California. At just 600 years old, Hyperion is a mere teenager compared to others who are 2,000, even 3,500 years old – they were already giants even as the Roman Empire was being founded in Europe. The older Hyperion gets, the thicker its trunk will grow. Some giant sequoias – like the huge tree known as General Sherman in Sequoia National Park, California – have trunk circumferences of over 30 metres. But none are as tall as Hyperion, which hasn't even finished growing yet.

The ascent is arduous; the trunk is smooth and wet. It takes Sillett an hour to reach the tree crown.

"It's like being swallowed by Hyperion," says the scientist. "Suddenly you find yourself in a foreign world – in a living organism." An array of mosses, lichens and fungi cover large swaths of the trunk. Insects have also established nests on its giant branches. Sillett is a dwarf in the bowels of a titan. The higher he climbs, the more carefully he must tread. At 110 metres, the branches become so thin and bendy that they can barely support his weight. He clings to the trunk for the last few metres until he emerges through the final curtain of pine needles. In the west he can see the Pacific Ocean. Sillett lets the tape measure fall to the ground: 115.66 metres.

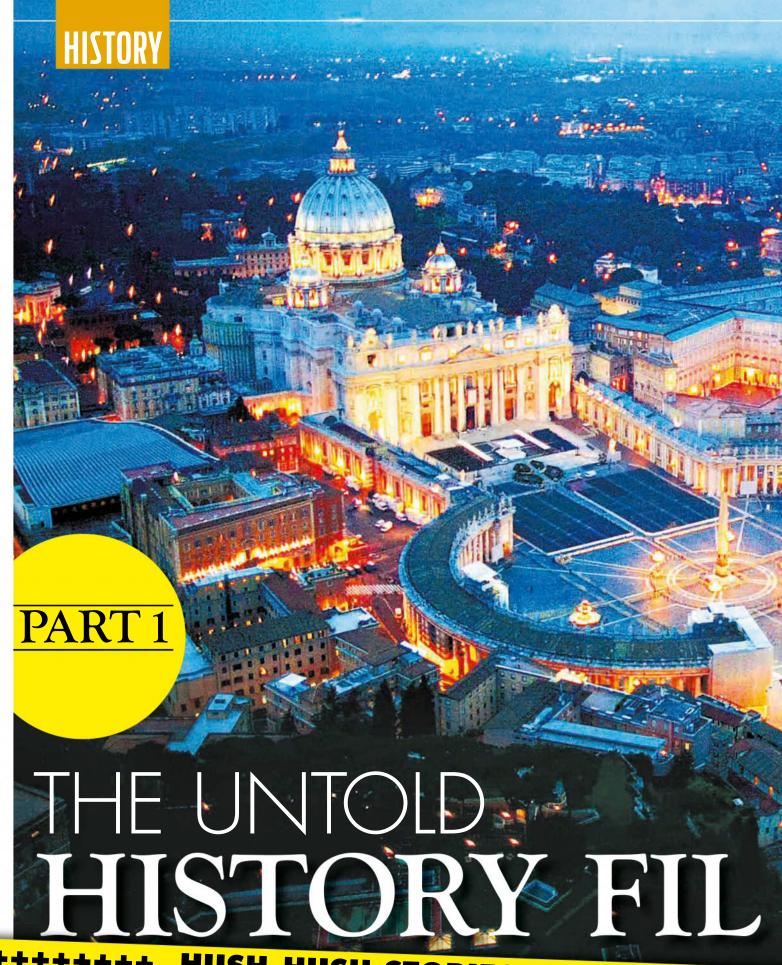
HOW TALL CAN A TREE GROW?

It's the proverbial search for the needle in a haystack. Every year, thousands of hikers traipse through the Redwood National Park searching for Hyperion – but so far hardly any have been able to find it. Only the scientists from the Institute for Redwood Ecology know the exact coordinates. The reason is that Hyperion is shallow-rooted and draws water from the uppermost layer of soil. Too many visitors would exert too much weight on the ground, compacting the soil and displacing the water near the surface. Every day Hyperion transports 1,000 litres of water from its roots to the crown. As the water must travel against gravity, via tiny capillary canals to the crown, there is a natural limit to how high a tree can grow – around 130 metres.

Hyperion will need another 100 years to achieve that height – but even then it'll still be a youngster.

▼





+++++++ HUSH-HUSH STORIES YOU WON'T FIR



WAS THE VATICAN BUILT ON A LIE?

Can a single document create a world power? Can an emperor bestow a gift that ensures 1,700 years of wealth and influence for its recipients? These are questions that for centuries the Vatican has been answering with a firm 'yes'. The story centres around a document called the Donation of Constantine, a decree considered the most important in the official history of the Catholic Church. But what if it proves to be a forgery? What if the event that led to the Vatican's central role on the world stage never actually took place?

When you visit the Vatican, you are setting foot in the smallest internationally recognised independent state in the world, with a total area of just 110 acres. But, as the federal state of the Catholic Church, the Vatican makes up for its lack of size by having 1.2 billion members, making the Catholic Church not only the biggest organisation on Earth, but also the biggest landowner in the Western world.

Its wealth and power are based on a document said to have been issued 1,697 years ago. Let's travel back in time to the year 317 AD. The setting is the Castel Sant'Angelo in Rome: it is the middle of the night when Silvester, the Bishop of Rome, is led into the Emperor's bedroom. Constantine, the leader of the Roman Empire, sits in semi-darkness, his face unrecognisable in the gloom. The **Emperor stopped appearing in public** a long time ago. As he turns to face the light, Silvester realises why the Emperor has hidden himself away: blotchy red marks cover his face and hands. His leprosy is still at an early stage. Constantine stands up, walks towards Silvester and looks him

directly in the eye. "Tonight your God appeared to me in a dream," says the Emperor. "He said that you could heal my disease." Constantine steps closer to Silvester – and now speaks the words that will turn a small religious community into the biggest faith on Earth: "I want to be baptised."

This event is recounted in a document which states that the ruler did indeed convert to Christianity, and that the Emperor was healed as a result of the baptism. In a gesture of thanks, Constantine effectively transferred authority of Rome and the western part of the Roman Empire to the Church. There's one major problem: the

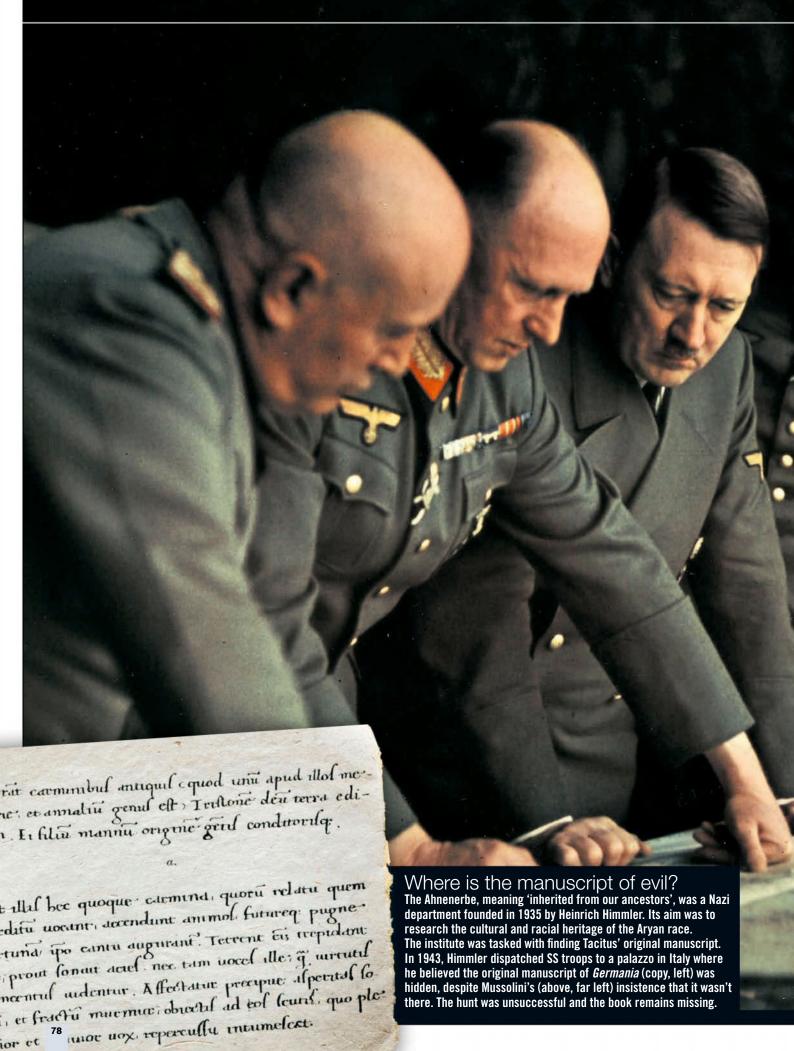
"AH, CONSTANTINE.
HOW MUCH EVIL WAS
BORN, NOT FROM YOUR
CONVERSION, BUT
FROM THAT DONATION."

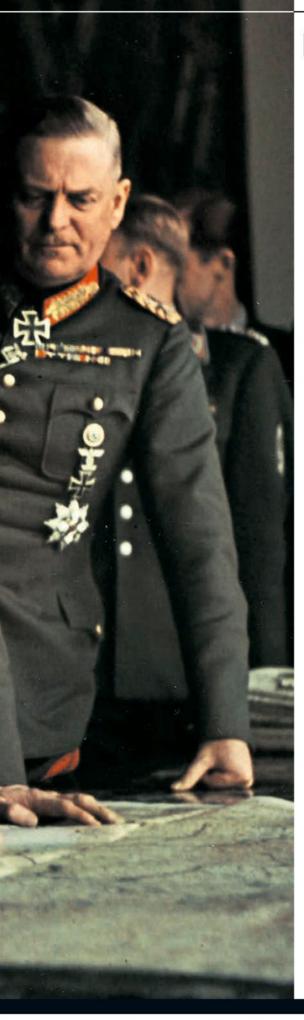
DANTE ALIGHIERI, *The Divine Comedy*

document is regarded by most historians as a forgery. Even today, it's unclear whether the meeting between Constantine and Silvester ever actually took place.

Over the following centuries, the Catholic Church grew and widened its influence, presiding over large swathes of Italy, entering politics and even commanding its own troops. Whenever the legal claims of the Church were called into question, the Pope would present the (fake) Donation of Constantine as evidence of its authenticity.

It was not until 1433 that the first doubts about the reliability of the Donation of Constantine were aired by the philosopher Nicholas of Cusa. Italian humanist Lorenzo Valla then added to these doubts by pointing out a glaring error in the document, which refers to the city as Constantinople. During Emperor Constantine's lifetime, the city was actually known as Byzantium. To this day, Rome has denied all accusations and insists on the document's authenticity.





DID THE NAZIS DATE BACK TO ANCIENT TIMES?

The beginning of the 20th century is regarded as the birth of fascism: the time when totalitarian regimes in Germany, Italy, Greece and the former Yugoslavia rose to power. In Germany, fascism was combined with the extreme racial ideology of National Socialism. What few people knows is the starting point of this ideology dates back far further than Adolf Hitler's Mein Kampf - to a book written 2,000 years before the dictator's manifesto by **Publius Cornelius Tacitus, one of** Rome's greatest historians. It's a work that would later become the justification for the most barbaric mass murder of all time.

98 AD: "The tribes of Germany are free from all taint of intermarriages with foreign nations, and they appear as a distinct, unmixed race, like none but themselves. Hence the same physical peculiarities throughout so vast a population. All have fierce blue eyes, reddish hair and tall, fit bodies well suited to fighting." What sounds like an extract from Mein Kampf is actually an extract from the work of Roman historian and senator Publius Cornelius Tacitus from the year 98 AD. In translation, Germania is just 30 pages long - and vet two millennia after it was written. the work became the handbook for the most dangerous and deadly political movement in the world: national socialism, or Nazism.

Tacitus describes the traditions and customs of the Germans, their lifestyles and traits: honesty, courage, purity and an incredible sense of family – that is

how the Roman historian saw these tribes, even though he had probably never set foot in Germany. Most of his theories were gleaned secondhand from Roman legions.

After disappearing for several centuries, and being presumed lost forever, a lone manuscript was found in the 15th century, just as the Germans were developing a sense of national identity for the first time. Germania offered an ideal chance to see the virtues of the German race rooted in the past. Some time later, the text triggered a dangerous Germanic cult. In 1910, race theorist Karl Ludwig Schemann wrote: "The Germans were a pure race, and thanks to this purity they achieved tremendous success. This has been proven from the time of Tacitus up until today."

But it is only Hitler who had a mind warped enough to misuse the text completely for his own ideology and to

"THE GLORIOUS IMAGE OF THE PURITY AND NOBLENESS OF OUR ANCESTORS."

HEINRICH HIMMLER, SS LEADER

take national socialism to extremes. *Germania* not only became an eponymous example for the planning of an imperial capital, the text also grew into a sort of clarion call for Hitler and his followers. As early as 1924 Heinrich Himmler had read about the purity and nobility of the ancient tribes in *Germania* and concluded enthusiastically, "Thus shall we be again – or at least some among us."

Today, choosing the most dangerous book of all time would probably come down to either Hitler's *Mein Kampf* or Tacitus' *Germania*. We can only speculate how national socialism might have looked if the book had not resurfaced, or if it would have even happened at all.





WAS KENNEDY A PUPPET OF HIS GENERALS?

Arguably, they were the most dangerous 13 days in history: in October 1962, the world found itself closer to a nuclear war than it ever had done before – or ever has since.

The situation became known as the Cuban Missile Crisis, a time when the USA and the Soviet Union were engaged in a standoff over the stationing of Russian nuclear rockets in Cuba. Soviet leader Nikita Khrushchev and US President John F. Kennedy both had their fingers on the red button – and both were prepared to press it at any moment. At least that's what the history books tell us. But in reality, it was much more dangerous than that...

On 27th October 1962, US President John F. Kennedy invites his brother Bobby to the White House. "Khrushchev has sent another letter," says the President. "He will withdraw the rockets from Cuba if we withdraw our rockets stationed in Turkey." Bobby shakes his head: "That would be political suicide for you, John. The National Security Council would never allow it." But that's not the president's only concern. For days he has been threatening the Soviets with a war that he can command. but not control. What nobody knows during this tense period is that although the US president is the supreme commander of the armed forces, the decisions about which weapons to use in a conflict situation lies with his general staff. The red button is not located in the White House, but in the defence ministry. At any moment the president worries that a US general might be firing missiles towards Russia. The generals' unpredictability worries Kennedy just as much as that of the Soviets.

Eventually, with a great deal of diplomatic skill and a secret agreement with Turkey, Kennedy succeeds in bringing Khrushchev round. The crisis has passed. But Kennedy does his utmost to ensure that a US president is never again faced with a similar situation. He succeeds in removing the military's power to deploy nuclear weapons with an ingenious trick: he introduces the so-called nuclear football, a briefcase containing the launch codes for nuclear weapons. As before, the briefcase is in the hands of a high-ranking officer. But now only the president himself can grant approval. In a single stroke, Kennedy simultaneously deprived the Pentagon of its power and strengthened the presidential office. Initially nothing is said about this change in power so that nobody loses face.

It's not hard to imagine how events
like the Vietnam War might have panned
out if the generals in office at the time
had controlled the deployment of atomic
weapons. For the Pentagon, Kennedy's
coup must have been a double-edged
betrayal: the withdrawal of the Jupiter
rockets from Turkey followed by loss of
control over the state's nuclear arsenal.
One thing's for sure: in the year before
his assassination, Kennedy was not
making any friends in the military.



Finger on the trigger
It was JFK who took the control of America's
nuclear arsenal away from the military.
Before that, the Pentagon was in charge of
deciding when they were deployed.





WERE THE SEEDS OF ISLAMIC STATE SOWN 100 YEARS AGO?

It's December 2014. Large parts of Iraq and Syria are controlled by militant terrorists from the Islamic State (IS) group. The terrorists' gruesome deeds dominate TV coverage as the world watches on helplessly, wondering how this could have happened. How can a terrorist army conquer so many regions in such a short space of time in the 21st century? The answer to this question takes us back 100 years — to a broken promise. A shattered vow that's the main reason why the world is now holding its breath...

November 1915: two diplomats meet in a backroom in Baghdad. They sit down at a massive wooden table and lay their rulers on the maps. Frenchman François Georges-Picot and British politician Sir Mark Sykes are negotiating the division of the Ottoman Empire. In a seemingly arbitrary fashion, they draw borders across the map with their pencils and, at this very moment, decide on the fate of some 2.6 million square kilometres of land and 20 million people. But in the process they make a crucial error: they are breaking a promise. As an ally of the British against the Turkish and German troops, the Arabs had been promised their own independent Arabic state after the end of the First World War.

Officially, Sykes and Picot fulfill their objective on this day. Their drawing of borders forms a basis for the founding of Iraq. But the way they drew the borders completely ignored the promised

independence for the Arabic tribes. Sykes and Picot are only interested in their own empires - and securing control of the oil and water resources in the area. Regions connected by ethnicity are divided, meaningless new borders are drawn up. Iraq is founded in 1920, but it is not a sovereign state. Over the years the British send in troops and change governments, until Saddam Hussein's Ba'ath Party seizes power in 1963. Decades of tyrannical rule follow, along with the Iraq-Iran War, the Gulf War and the Iraq War which eventually led to the fall of Saddam in 2003.

The pencil marks of Sykes and Picot laid the foundation for almost 100 years of war, persecution and massacre in the Middle East – and for the development of several terrorist organisations. "The artificial national boundaries have triggered numerous conflicts over recent decades," says Henner Fürtig, an expert in Middle Eastern affairs.

"THE OTTOMAN EMPIRE SHOULD HAVE BEEN PRESERVED AFTER ITS DEFEAT. ANYTHING ELSE WOULD HAVE HAD DEVASTATING CONSEQUENCES."

BERNARD LEWIS, HISTORIAN

The triumph of Islamic State troops is – for the time being – the latest low point in the British-French diplomacy that was set in motion almost 100 years ago. In July the leader of IS, Abu Bakr al-Baghdadi, declared: "This blessed advance will not stop until we hit the last nail in the coffin of the Sykes-Picot conspiracy." They have presented Europe with a chilling ultimatum: "Do away with your old promises, otherwise we will destroy you."

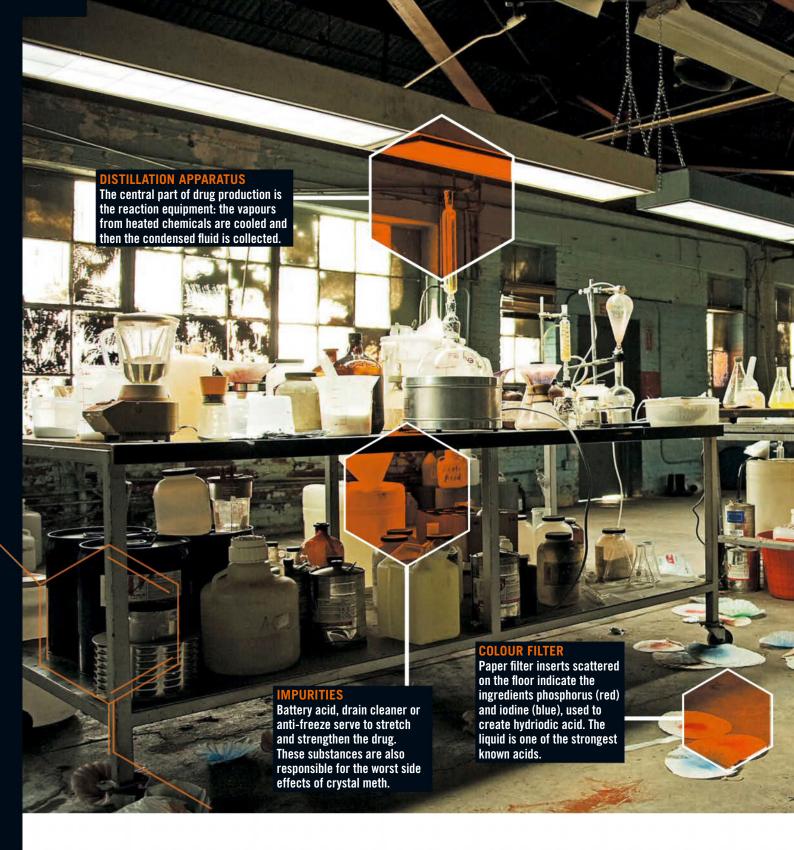
Knowledge LABTEST

Dr Z is the world's most prolific designer of legal drugs. His secret? Inventing drugs faster than the authorities can ban them.
But how dangerous are the substances designed by the biochemist? And how does the world market of legal highs function?



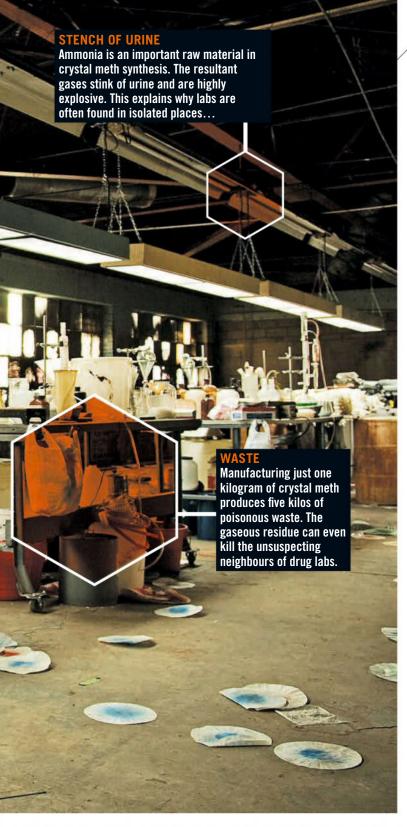


+ HIS LEGAL HIGHS



axter pulls the needle out of his arm and waits: "First comes the bad part." Wincing in pain, he keels over to the side and holds his arm. He looks like you might imagine a drug addict to look: scrawny, deathly pale with dark circles ringing his eyes. His gaze is empty and his arms are covered in scabbed-over wounds. But, despite his exhausted appearance, minutes later he is euphoric, shouting

in a slurred voice: "I am so happy, so happy." Baxter laughs, swaying back and forth. The drug addict from Melbourne is now experiencing his favourite buzz, one triggered by methoxyketamine. This substance has an intoxicating effect similar to that of the anaesthetic ketamine, and its side effects – nausea, organ damage and psychosis – are similar. There's only one major difference: methoxyketamine is legal, whereas ketamine is not.



WHAT IS A LEGAL DRUG?

Legal highs are substances that imitate the effects of known illegal drugs like cocaine, heroin or marijuana. Often their chemical composition differs only slightly from the original. But sometimes that small variation is enough for these substances not to fall under drug legislation and because of this they are not officially banned – neither the dealer nor the buyer have broken the law. Not yet in any case. For Dr Z, it's an opportunity to find a new formula. The pharmacologist

THE PRODUCTION OF CRYSTAL METH

Ecstasy has been banned in Australia since 1986, but the popular narcotic crystal meth is easy to make: it can be produced on an industrial scale in a synthesis laboratory (left), but is also just as easy to make in a domestic kitchen or even in the boot of a car. Common cold medicines are the raw material. The ephedrine they contain works as a decongestant and is chemically similar to the active ingredient in crystal meth (methamphetamine). But producing it can be fatal, especially if the manufacturers are high themselves.

is a major player in a booming industry, whose best sellers are hidden behind complicated names like 5-FAKB48, methiopropamine and methoxyketamine.

Dr Z keeps his real name secret, but still makes a case for his products: "Healthy, adult people should be able to make their own decisions," he says, defiantly.

For years, Dr Z was a researcher for an agribusiness company. Today, he splits his time between the Netherlands and Israel and only develops new drugs. His biggest success to date has been the substance mephedrone (meow meow), which flooded Europe before it was banned in 2010. He's now working on his next big thing: "So far I have developed around 50 psychoactive substances."

HOW DO YOU MAKE A LEGAL HIGH?

Dr Z sees himself as a researcher. "When I discover a new substance, I share it with the world. But before I do, I try microscopically small doses on myself. I don't want other people to be my guinea pigs," he says.

But, in reality, that's exactly what they are. Experts are of the firm opinion that you cannot assess the potential danger of an unknown substance by conducting a few tests on yourself. Not for nothing does the pharmaceutical industry trial new active substances on thousands of test subjects over a period of several years.

The use of legal highs remains a risk: many of the drugs now classified as highly dangerous, like LSD, were once considered safe and were even available on prescription. The same can be said of these new substances. "Legal drugs cause at least as much damage as illegal ones," says Wim van den Brink, professor of psychiatry and addiction at the University of Amsterdam. Toxicologist Dr John Ramsay at St George's Hospital in London attests that often



THE WORLD'S LARGEST LEGAL DRUG KITCHENS

It's easy to become a drug producer: legal highs are often substances that were considered by the pharmaceutical industry as potential medications, but were later rejected — mainly because they made the patients high. Drug dealers sift through medical publications for examples of these substances, then produce them in China or the Philippines, branding them as 'plant fertilisers' to disguise their real purpose. It costs about \$3,600 to produce 25kg. The market price can be over 100 times that.

just a few molecules separate the illegal original version and the legal copy. Take methylamphetamine. It is the active ingredient in crystal meth, one of the most dangerous and highly addictive synthetic drugs. Australia has the highest use of any developed nation, and addiction rates are on the rise: "A minor molecular alteration is enough to change methylamphetamine into a substance called methiopropamine," explains Ramsay, who works as a drug hunter at St George's. "

The effects remain the same, but so does the potential for addiction. To date, the substance is legally unregulated." Ramsay's work sees him informing the government whenever a new substance comes onto the market – something that happens frequently. His office is home to the UK's largest collection of legal highs, a number that currently stands at around 29,000. After his tip-off, it usually takes a year for the substance to be blacklisted.

This game of cat and mouse is seemingly endless: every time the government bans a substance, pharmacologists like Dr Z get to work and introduce a new version onto the market. "The brain is influenced by 500, maybe more, endogenous substances," explains Dr Z. "It is very likely that each of these chemicals has up to 1,000 variants – all of which can be explored."

HOW DOES THE LEGAL DRUG MARKET WORK?

The selection changes constantly: hundreds of variants are often sold under generic brand names such as 'Spice'. This makes it difficult for users to determine what they're actually taking – and how much of the drug they should take to achieve a high. "The consumer often doesn't know the correct dosage and takes too much," says Ramsay.

Unlike the pharmaceutical industry, manufacturers of legal highs do not provide information leaflets with their products. Other than trial and error, which can be dangerous, internet forums are the only source of information. "Remember: just because it's legal doesn't mean it's safe," says Professor Simon Thomas of the National Poisons Information Service. It's a point echoed by Brisbane resident Brooke, who left rehab earlier this year after being admitted for a mephedrone addiction: "Legal highs fry your brain," says the 24-year-old. "Nobody knows what goes in them. That's why they're so dangerous."

Consumers like Baxter, however, are not put off by the side effects. The drugs are legal and, because they are newly developed, difficult to detect using blood tests. In practice, demand is the regulator – and to a certain extent this is even desirable. "If we banned all new substances as a precaution, the methods would become more and more experimental and the effects even more unpredictable," says John Ramsey. In that scenario, someone like Baxter would probably have dropped dead a long time ago. \blacksquare



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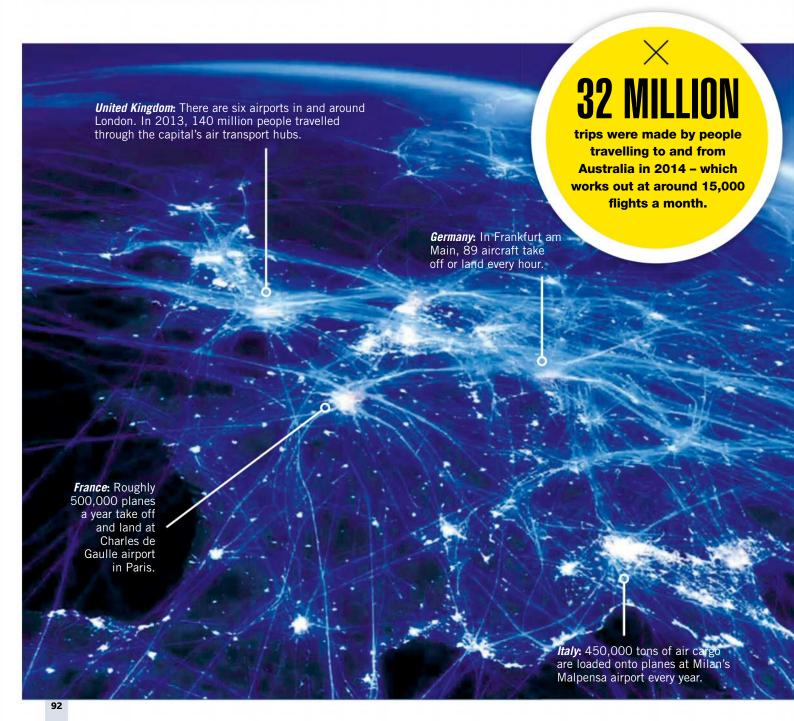
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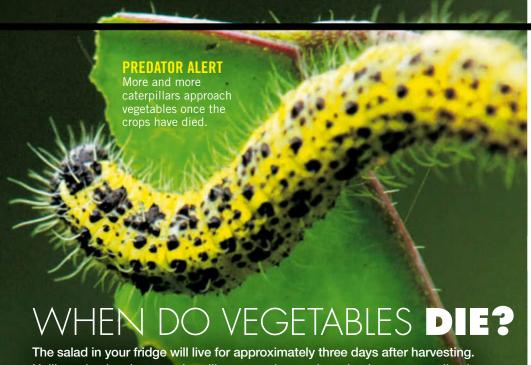


WHERE IS THE SKY MOST CROWDED?

What looks like a tangled network of laser beams is actually an illustration of the flight paths on a single day over Europe – the most crowded airspace in the world. The National Air Traffic Service (NATS) evaluated all of the data amassed on a typical summer's day, which saw more than 30,000 planes criss-crossing European airspace. The planes navigate safely back and forth with the help of 60 control centres. Why so many? The airspace over Europe is a huge

patchwork quilt – every country controls its own piece of sky. When flying into a new region, the pilot must not only accommodate a new air traffic controller, but also – dependent on the area's guidelines – adjust the plane's flight path, altitude and speed according to specific regulations. This 'fragmentation of airspace' is thought to cost an extra \$8 billion a year. The project Single European Sky aims to divide Europe into just nine centrally coordinated blocks.





The salad in your fridge will live for approximately three days after harvesting. Unlike animals, plants are less like a complete entity – they're more a collection of various individual components like the roots, stem, leaves and fruits. Some of these can survive for a significant period of time independent of the other parts. Researchers discovered that processes governed by circadian rhythms can be preserved, meaning the vegetable still contains glucosinolates up to 72 hours after being picked. In the wild, these glucosinolates can put off predators such as caterpillars, but they're also thought to inhibit cancer in humans. Only after three days will the head of lettuce cease its biological activity – and wilt.

HOW QUICKLY CAN A PERSON FREEFALL THROUGH THE AIR?

A skydiver falls from a height of 4,000 metres, accelerating by 32km/h every second. After three seconds, they are falling at a speed of over 100km/h. The reason? Gravity. This force accelerates a body in freefall by 9.81 metres per second, every second. During a 60-second jump, a person would theoretically achieve a mind-boggling speed of 2,100km/h, breaking the sound barrier about halfway through the jump. However, air resistance counteracts gravity and slows down the skydiver. With arms outstretched, this means a skydiver will only achieve a speed of 195km/h. With arms raised above the head, they'll reach 320km/h.



HOW WELL DO WE REMEMBER OUR CHILDHOODS?



Infants and toddlers (0-2 years)

Studies show that infants and toddlers are already able to store short, simple memories up to the age of two.



Toddlers (2-3)

The hippocampus, the part of the brain responsible for the long-term memory, begins to mature. As a result, toddlers are able to retain important information and memories.



Young children (4-7)

The short-term memory continues to develop as does the predictive memory. Thanks to this capability, children develop the ability to plan activities and remember them at a later time.



Children (8-10)

This is when most forgetting happens: two-thirds of memories from before the third year of life are lost because they cannot be transferred from the preliminary to the permanent storage system. Spatial awareness also becomes stronger at this time.



Pre-teens (10-12)

The hippocampus reaches its full size. The long-term memory continues to improve, while the ability to separate memories according to importance and to suppress traumatic memories also forms fully.



Young adults (13-21)

The temporal cortex, which helps the brain to order and categorise memories, and the prefrontal cortex, which is responsible for short-term memory, reach maturity in the early 20s. Our memories become more complex and more detailed than in previous years.

HOW DO YOU MAKE A KNIFE?

Two million years ago humans took stones and, with a few adjustments, fashioned knifes from them by giving them the necessary edges. Since then, knife production has come a long way. These days, the treatment of metal under extreme heat is the generally accepted method.

US engineer Chris Hackett tested how to manufacture a knife without the help of a blacksmith. His 'knife recipe' is ingenious, but don't try it at home! Hackett drilled a hole in the bottom of a bucket, fed in a small blowtorch, and filled it with fire-resistant stones and rock wool in order to trap massive amounts of heat. Within 15 minutes, the homemade forge reached 1,000°C – the temperature at which the structure of metal breaks down and becomes malleable. He put a piece of scrap metal in the bucket for eight minutes until it glowed red,

then shaped the tool with a hacksaw. To ensure the knife kept its shape, he cooled it slowly in pre-warmed rapeseed oil. After he sharpened it with a file, the knife was ready.



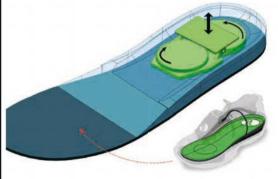
N V aa ee u n n t t

MUSCLE POWER

What appears easy actually takes a major effort: the snake uses up to five times more energy than necessary to hold on to something – out of fear of falling.

HOW STRONG ARE SNAKES?

When snakes wriggle along branches, they might appear pretty relaxed. But appearances can be deceiving: the snake is clinging onto the branch with all its might. That's because, depending on the snake's size and weight and the texture of the ground, a fall could prove fatal. A tumble from a height of just 1.5 metres could break several of its 200 to 400 vertebrae or cause internal injuries to organs.



ENERGY During

every step, a small generator spins to create electricity.

CANTUSE MY SHOES TO CHARGE A BATTERY?

The energy that results from your foot touching the ground could be used to light up a bulb. Engineer Matt Staton has created an insole called SolePower which stores this energy. Using magnetic rotors, a drivetrain converts it into rotational energy. The movement of the rotors allows the energy to flow through a wire and even to be hooked up to a mobile phone with a USB cable. Charging your phone while walking? No problem. You'll need to walk a route of between three and six kilometres to generate enough energy though!

QUESTIONS ABOUT CLOUDS

CAN CLOUDS LIGHT UP THE NIGHT?

In the summer months, clouds sometimes glow a range of different colours: on occasion a pale yellow, at other times a pearlescent silver. Ice crystals are responsible for these glowing clouds (known as noctilucent clouds) as they reflect the light of the setting sun.

HOW CAN YOU TAP INTO A CLOUD?

Researchers often take samples of clouds. Scientists have installed special apparatus on top of the French volcano Puy de Dôme at an altitude of 1,465 metres. The device is able to collect 25ml (almost two tablespoons) of cloudwater per hour.

DOES A CLOUD CONSIST OF WATER VAPOUR?

Yes and no. A cloud consists of aerosols (a collection of fine dust and salt particles which are so light and small that they can be carried by the air) and a gas. Water vapour is this gas. It is invisible and not to be confused with the steam that comes out of the kettle. In this case, it is actually condensed water particles.

ARE THERE NEW TYPES OF CLOUDS?

The World Meteorological Organisation (WMO) recognises ten types of cloud and their subtypes. Experts are currently campaigning for the recognition of a new type: the undulatus asperatus. This type of cloud looks like a massive ocean wave and often forms close to the edge of a storm.

CAN CLOUDS SUCK IN OBJECTS?

In Australia, a German paraglider reached a cruising altitude of 700 metres but found herself sucked to a height of 10,000 metres by a storm cloud. Thermal lift makes this possible: the warm updraft rises upwards and a slipstream develops when the supplies of warm air are pulled downwards. The woman lost consciousness at a temperature of minus 45°C while being dragged through the clouds, but managed to survive – albeit with severe frostbite.

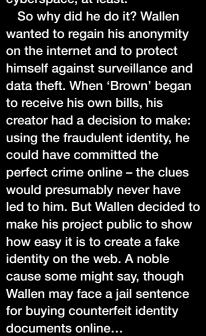
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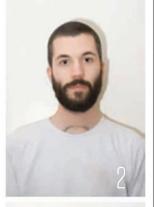
Photo 1: the fictitious Aaron Brown – a compilation of passport photos of Curtis Wallen (photo 2) and his three housemates (photos 3-5).



HOW DO I Invent A Person?

Curtis Wallen, 25, from Brooklyn, New York, created a new human on the internet by blending passport photos of himself and his housemates. The person's name? Aaron Brown. But a fake identity also needs to have an online life to appear credible: hobbies, identity documents - a person has to leave a footprint. For that purpose, Curtis Wallen delved into the underworld of the internet. With the help of anonymous dealers, he applied for a boat licence, a student ID and a driving licence. This brought 'Brown' to life - in cyberspace, at least.











PLEASE DON'T LOOK AROUND!

A new extreme diving craze is sweeping Mexico: croc diving. But if you don't stick to the crocodile's rules, you might end up as its prey

Diving with killer whales? So last year! Gliding over the ocean floor with manta rays? Been there, done that! Swimming with a great white? Booooooring! Extreme divers like to brag about these sorts of things. Most are in constant competition with one another, forever trying to pull off the latest daredevil stunts and pose for the gnarliest photos. Now, they're challenging a predator that has been on the planet for more than 100 million years — one whose body language is about as easy to read as a plank of wood.

To the east of Mexico's Yucatan peninsula, a mecca for croc diving is developing. In the Banco Chinchorro atoll, the water teems with American crocodiles, reptiles that can grow up to seven metres long and weigh up to 900 kilograms. Of course, no diver would dream of entering the water when one of these colossal beasts is in evidence – sensibly, they prefer diving with the smaller three- to four-metre specimens, like the one shown here. For while American crocodiles mostly feed on fish, reports of fatal attacks on humans are becoming more and more frequent.

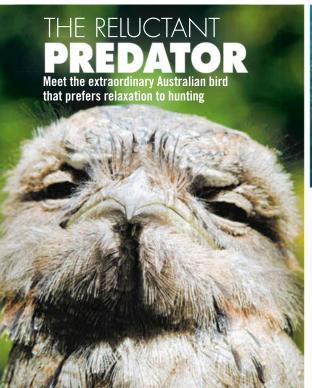
Zoologist Adam Britton dives with crocodiles in a professional capacity to find out more about their behaviour. "There are three rules to follow when you take to the water with crocodiles," he says. "Stay far from the shore – otherwise you're prey. Dive quickly under the surface – otherwise you're prey. And stay away from the croc's mouth – otherwise you're prey."

The only protection the divers carry is the underwater camera that they hold in their outstretched arms. But they know it wouldn't be much help in a worst-case scenario. Quick as a flash, these reptiles can spin round and maul your arm with a biting force of around 1,000 kilograms per square centimetre. The much safer option: observing them from the shore. But where's the thrill in that?

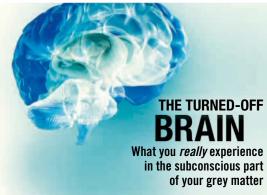


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